A. CHINOOK SALMON

A.1 BACKGROUND AND HISTORY OF LISTINGS

Primary contributor: James M. Myers
(Northwest Fisheries Science Center)

Chinook salmon (*Oncorhynchus tshawytscha* Walbaum), also commonly referred to as king, spring, quinnat, Sacramento, California, or tyee salmon, is the largest of the Pacific salmon (Myers et al. 1998). The species historically ranged from the Ventura River in California to Point Hope, AK in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of Northern Canada (McPhail and Lindsey 1970). Chinook salmon exhibit very diverse and complex life-history strategies. Healey (1986) described 16 age categories for chinook salmon, seven total ages with three possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): “stream-type” chinook salmon reside in freshwater for a year or more following emergence, whereas “ocean-type” chinook salmon migrate to the ocean predominately within their first year. Healey (1983, 1991) has promoted the use of broader definitions for “ocean-type” and “stream-type” to describe two distinct races of chinook salmon. This racial approach incorporates life-history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations. For this reason, the BRT has adopted the broader “racial” definitions of ocean- and stream-type for this review.

Of the two life-history types, ocean-type chinook salmon exhibit the most varied and plastic life-history trajectories. Ocean-type chinook salmon juveniles emigrate to the ocean as fry, subyearling juveniles (during their first spring or fall), or as yearling juveniles (during their second spring), depending on environmental conditions. Ocean-type chinook salmon also undertake distinct, coastally oriented, ocean migrations. The timing of the return to freshwater and spawning is closely related to the ecological characteristics of a population’s spawning habitat. Five different run times are expressed by different ocean-type chinook salmon populations: spring, summer, fall, late-fall, and winter. In general, early run times (spring and summer) are exhibited by populations that use high spring flows to access headwater or interior regions. Ocean-type populations within a basin that express different runs times appear to have evolved from a common source population. Stream-type populations appear to be nearly obligate yearling outmigrants (some 2-year-old smolts have been identified), they undertake extensive off-shore ocean migrations, and generally return to freshwater as spring-run- or summer-run fish. Stream-type populations are found in northern British Columbia and Alaska, and in the headwater regions of the Fraser River and Columbia River interior tributaries.

Prior to development of the ESU policy (Waples 1991), the NMFS recognized Sacramento River winter-run chinook salmon as a “distinct population segment” under the ESA (NMFS 1987). Subsequently, in reviewing the biological and ecological information concerning

West Coast chinook salmon, Biological Review Teams (BRTs) have identified additional ESUs for chinook salmon from Washington, Oregon, and California: Snake River fall-run (Waples et al. 1991), Snake River spring- and summer-run (Matthews and Waples 1991), and Upper Columbia River summer-run- and fall-run chinook salmon (originally designated as the mid-Columbia River summer-run- and fall-run chinook salmon, Waknitz et al. 1995), Puget Sound chinook salmon, Washington Coast chinook salmon, Lower Columbia River chinook salmon, Upper Willamette River chinook salmon, Middle Columbia River spring-run chinook salmon, Upper Columbia River spring-run chinook salmon, Oregon Coast chinook salmon, Upper Klamath and Trinity rivers chinook salmon, Central Valley fall-run and late-fall-run chinook salmon, and Central Valley spring-run chinook salmon (Myers et al. 1998), the Southern Oregon and Northern California chinook salmon, California Coastal chinook salmon, and Deschutes River (NMFS 1999).

Of the 17 chinook salmon ESUs identified by the NMFS, eight are not listed under the United States ESA, seven are listed as threatened (Snake River spring- and summer-run chinook salmon, and Snake River fall-run chinook salmon [Federal Register, Vol. 57, No. 78, April 22, 1992, p. 14653]; Puget Sound chinook salmon, Lower Columbia River chinook salmon, and Upper Willamette River chinook salmon [Federal Register, Vol. 64, No. 56, March 24, 1999, p. 14308]; Central Valley fall-run, and California Coastal chinook salmon [Federal Register, Vol. 64, No. 179, September 16, 1999, p. 5039]), and two are listed as endangered (Sacramento River winter-run chinook salmon [Federal Register, Vol. 59, No. 2, January 4, 1994, p. 440], and Upper Columbia River spring-run chinook salmon [Federal Register, Vol. 64, No. 56, March 24, 1999, p. 14308]).

The NMFS convened a BRT to update the status of listed chinook salmon ESUs in Washington, Oregon, California, and Idaho. The chinook salmon BRT[1] met in January, March and April of 2003 in Seattle, Washington, to review updated information on each of the ESUs under consideration.

[1] The Biological Review Team (BRT) for the updated chinook salmon status review included, from the NMFS Northwest Fisheries Science Center: Thomas Cooney, Dr. Robert Iwamoto, Dr. Robert Kope, Gene Matthews, Dr. Paul McElhaney, Dr. James Myers, Dr. Mary Ruckelshaus, Dr. Thomas Wainwright, Dr. Robin Waples, and Dr. John Williams; from the NMFS Southwest Fisheries Science Center: Dr. Peter Adams, Dr. Eric Bjorkstedt, and Dr. Steve Lindley; from the NMFS Alaska Fisheries Science Center (Auke Bay Laboratory): Alex Wertheimer; and from the USGS Biological Resource Division: Dr. Reginald Reisenbichler.

A.2.1 SNAKE RIVER FALL-RUN CHINOOK SALMON

Primary contributor: Thomas Cooney
(Northwest Fisheries Science Center)

Snake River fall-run chinook salmon enter the Columbia River in July and August. The Snake River component of the fall chinook salmon run migrates past the Lower Snake River mainstem dams from August through November. Spawning occurs from October through early December. Juveniles emerge from the gravels in March and April of the following year. Snake River fall-run chinook salmon are subyearling migrants, moving downstream from natal spawning and early rearing areas from June through early fall.

Fall-run chinook salmon returns to the Snake River generally declined through the first half of this century (Irving and Bjornn 1981). In spite of the declines, the Snake River basin remained the largest single natural production area for fall-run chinook salmon in the Columbia River drainage into the early 1960s (Fulton 1968). Spawning and rearing habitat for Snake River fall-run chinook salmon was significantly reduced by the construction of a series of Snake River mainstem dams. Historically, the primary spawning fall-run chinook salmon spawning areas were located on the upper mainstem Snake River. Currently, natural spawning is limited to the area from the upper end of Lower Granite Reservoir to Hells Canyon Dam, the lower reaches of the Imnaha, Grande Ronde, Clearwater and Tucannon Rivers, and small mainstem sections in the tailraces of the Lower Snake hydroelectric dams.

Adult counts at Snake River dams are an index of the annual return of Snake River fall-run chinook salmon to spawning grounds. Lower Granite Dam is the uppermost of the mainstem Snake River dams that allow for passage of anadromous salmonids. Adult traps at Lower Granite Dam have allowed for sampling of the adult run as well as for removal of a portion of non-local hatchery fish passing above the dam. The dam count at Lower Granite covers a majority of fall-run chinook salmon returning to the Snake basin. However, Snake River fall-run chinook salmon do return to locations downstream of Lower Granite Dam and are therefore not included in the ladder count. Lyons Ferry Hatchery is located on the mainstem Snake River below both Little Goose and Lower Monumental Dams. Although a fairly large proportion of adult returns from the Lyons Ferry Hatchery program do stray to Lower Granite Dam, a substantial proportion of the run returns directly to the facility. In addition, mainstem surveying efforts have identified relatively small numbers of fall-run chinook salmon spawning in the tailraces of lower Snake River mainstem hydroelectric dams (Dauble et al. 1999).

Lyons Ferry Hatchery was established as one of the hatchery programs under the Lower Snake Compensation Plan administered through the Unites States Fish and Wildlife Service. Snake River fall chinook. Snake River fall-run chinook salmon production is a major program for Lyons Ferry Hatchery, which is operated by the Washington Department of Fish and Wildlife and is located along the Snake River main stem between Little Goose Dam and Lower Monumental Dam. WDFW began developing a Snake River fall-run chinook salmon broodstock in the early 1970s through a trapping program at Ice Harbor Dam and Lower Granite Dam. The Lyons Ferry facility became operational in the mid-1980s and took over incubation and rearing for the Snake River fall chinook mitigation/compensation program.

A.2.1.1 Summary of Previous BRT Conclusions

Previous chinook salmon status reviews (Waples et al. 1991, Myers et al. 1998) identified several concerns regarding Snake River fall-run chinook salmon: steady and severe decline in abundance since the early 1970s; loss of primary spawning and rearing areas upstream of the Hells Canyon Dam complex; increase in non-local hatchery contribution to adult escapement over Lower Granite Dam, and relatively high aggregate harvest impacts by ocean and in-river fisheries.

A.2.1.2 New Data and Updated Analyses

A major Snake River fall-run chinook salmon supplementation effort based upon the Lyons Ferry Snake River fall-run chinook salmon broodstock has been implemented in recent years (Bugert and Hopley, 1989; Bugert et al. 1995). Facilities adjacent to major natural spawning areas have been used to acclimate release groups of yearling smolts. Additional releases of sub-yearlings have been made in the vicinity of the acclimation sites. The level of subyearling releases depends upon the availability of sufficient broodstock to maintain the on-station program and the off-station yearling releases (Table A.2.1.1). Returns in 2000 and 2001 reflect increases in the level of off-station plants and relatively high marine survival rates.

Abundance

The 1999 NMFS status review update noted increases in the Lower Granite Dam counts in the mid-1990s (Figure A.2.1.1), and the upward trend in returns has continued; the 2001 count over Lower Granite Dam exceeded 8,700 adult fall-run chinook salmon. The 1997 through 2001 escapements were the highest on record since the count of 1,000 in 1975. Returns of naturally produced chinook salmon and increased hatchery returns from the Lyons Ferry Hatchery (on-station releases and supplementation program) account for the increase in escapements over Lower Granite Dam (Table A.2.1.2).

Returns classified as natural origin exceeded 2,600 in 2001. The 1997-2001 geometric mean natural-origin count over Lower Granite Dam was 871 fish, approximately 35% of the delisting abundance criteria proposed for this run (2,500 natural-origin spawners averaged over an 8 year period). The largest increase in fall-run chinook salmon returns to the Snake River spawning area was from the Lyons Ferry Snake River stock component. Returns increased from under 200/year prior to 1998 to over 1,200 and 5,300 adults in 2000 and 2001, respectively. The increase includes returns from the on-station release program as well as returns from large supplementation releases above Lower Granite Dam. Smolt releases from the acclimation sites above Lower Granite Dam have been marked. In recent years, large numbers of unmarked subyearling Lyons Ferry fall chinook have been released from the acclimation sites. These fish will contribute to adult returns over Lower Granite Dam, complicating the estimation of natural production rates (WDFW 2003). Escapement over Lower Granite Dam represents the majority of Snake River fall-run chinook salmon returns. In addition, Snake River fall-run chinook salmon returns to the Tucannon River (less than 100 spawners per year based on redd counts) system and to Lyons Ferry Hatchery (recent average returns to the facility have been approximately 1100 fish/year). Small numbers of fall-run chinook salmon redds have also been reported in tailrace areas below the mainstem Snake River dams (Dauble et al. 1999).

Table A.2.1.1. Escapement and stock composition of fall-run chinook salmon at Lower Granite Dam, 1975-2001; stock composition based on mark recoveries from Lower Granite Dam adult trapping (from Henry Yuen (USFWS Vancouver, WA) U.S. v. Oregon Technical Advisory Committee data base). Returning adults produced from naturally spawning parents (regardless of the origin of the parents) are classified as natural origin.

				Stock Composition of Lower Granite Dam Escapement		
Run Year	**Lower Granite Dam Count**	**Marked Fish to Lyons Ferry Hatchery**	**Lower Granite Dam Escapement**	**Natural-Origin**	**Hatchery-Origin (Snake River)**	**Hatchery-Origin (Non-Snake River)**
1975	1000		1000	1000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1067	430	637	350	1	286
1996	1308	389	919	639	74	206
1997	1451	444	1007	797	20	190
1998	1909	947	962	306	479	177
1999	3381	1519	1862	905	879	78
2000	3830	1372	2458	857	1278	323
2001	10782	2064	8718	2652	5330	736

Table A.2.1.2. Fall chinook hatchery releases into the Snake River basin. All releases are from Lyons Ferry Hatchery-origin broodstock. On station releases and acclimation site “Yearling” releases are marked or tagged; acclimation site “Sub-yearling” releases are generally unmarked (1994-2001 data are from Milks et al. (2003); 1985-1993 release data are from the Fish Passage Center Hatchery database.

			Acclimation Sites							
	Lyons Ferry (Direct)		Pittsburg Landing		Capt. John		Big Canyon (Clearwater R.)		Hells Canyon Dam[1]	
Release Year	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling
1985	650,300	539,392	-	-	-	-	-	-	-	-
1986	481,950	1,789,566	-	-	-	-	-	-	-	-
1987	386,600	1,012,500	-	-	-	-	-	-	-	-
1988	407,500	4,563,500	-	-	-	-	-	-	-	-
1989	413,017	1,710,865	-	-	-	-	-	-	-	-
1990	436,354	3,043,756	-	-	-	-	-	-	-	-
1991	224,439	-	-	-	-	-	-	-	-	-
1992	689,601	-	-	-	-	-	-	-	-	-
1993	206,775	-	-	-	-	-	-	-	-	-
1994	603,661	-	-	-	-	-	-	-	-	-
1995	349,124	-	-	-	-	-	-	-	-	-
1996	407,503	-	114,299	-	-	-	-	-	-	-
1997	456,872	-	147,316	-	-	-	199,399	252,705	-	-
1998	419,002	-	141,814	-	133,205	-	61,172	-	-	-
1999	432,166	204,194	142,885	-	157,010	-	229,608	347,105	-	-
2000	456,401	196,643	134,709	400,156	131,186	892,847	131,306	890,474	-	-
2001	338,757	199,976	103,741	374,070	101,976	501,129	113,215	856,968	-	115,251

[1] Hells Canyon Dam releases increased to 500,000 in 2002

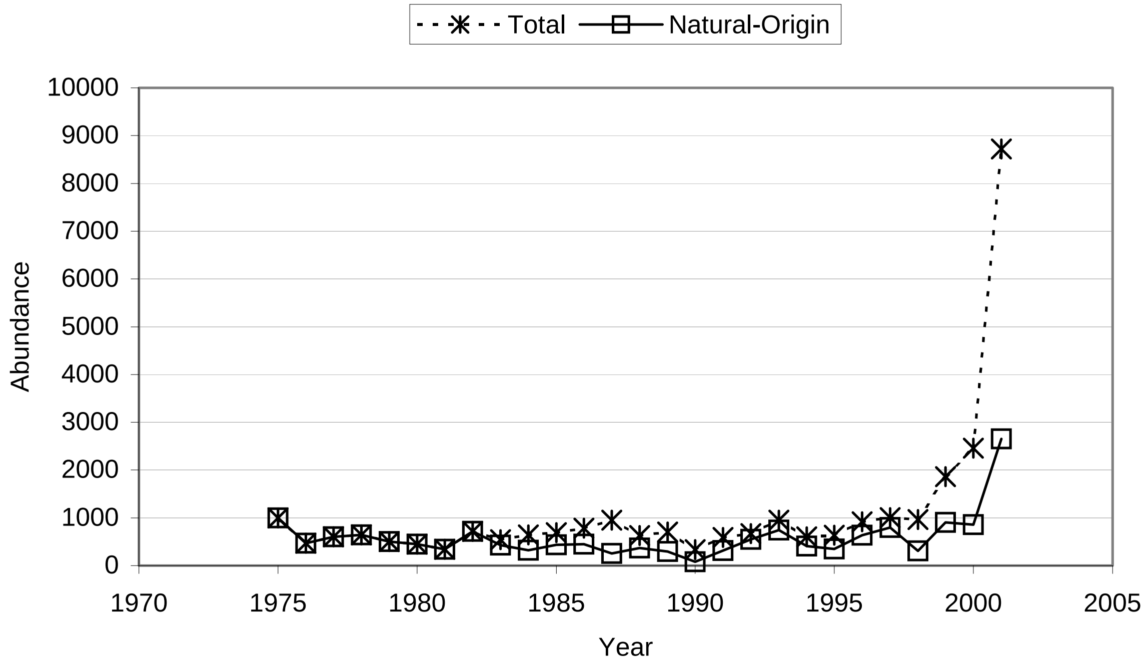

Figure A.2.1.1. Estimated spawning escapement of fall-run chinook salmon at Lower Granite Dam.

Productivity

Both the long-term and short-term trends in total returns are positive (1.05, 1.22). The short-term (1990-2001) estimates of the median population growth rate λ are 0.98 assuming a hatchery spawning effectiveness of 1.0 (equivalent to that of wild spawners) and 1.137 with an assumed hatchery spawning effectiveness of 0. The estimated long-term growth rate for the Snake River fall-run chinook salmon population is strongly influenced by the hatchery effectiveness assumption. If hatchery spawners have been equally as effective as natural-origin spawners in contributing to broodyear returns, the long-term λ estimate is 0.899 and the associated probability that λ is less than 1.0 is estimated as 99%. If hatchery returns over Lower Granite Dam are not contributing at all to natural production (hatchery effectiveness of 0.0), the long-term estimate of λ is 1.024. The associated probability that λ is less than 1.0 is 0.26.

Broodyear return-per-spawner (r/s) estimates were low for three or more consecutive years in the mid-1980s and the early 1990s (Figure A.2.1.2). The large increase in natural abundance in 2000 and 2001 is reflected in the 1996 and 1997 return-per-spawner estimates (1997 r/s is based on 4-year-old component only).

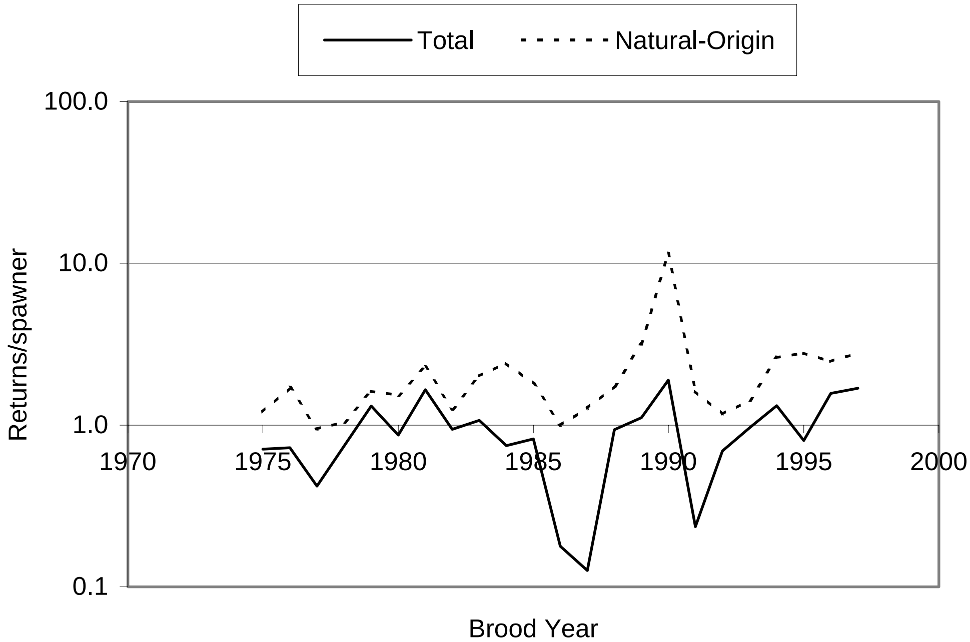

Figure A.2.1.2. Return/spawner plotted against brood year escapements for Snake River fall-run chinook (escapement estimates from Lower Granite Dam counts assuming a 10% pre-spawning mortality; brood year returns estimated by applying sample age at return estimate to annual dam counts.

Harvest impacts

Snake River fall-run chinook salmon are subject to harvest in a wide range of fisheries due to their patterns of ocean distribution and the timing of their spawning run up the Columbia River. Coded-wire tag studies using Lyons Ferry Hatchery fish of Snake River origin indicate that Snake River fall-run chinook salmon have a broad distribution. Recoveries of tagged fish from the Snake River have been reported from coastal fisheries from California, Oregon, Washington, British Columbia and Southeast Alaska. The timing of the return and upriver spawning migration of Snake River fall-run chinook salmon overlaps with the Hanford Reach up-river bright chinook salmon returns as well as with several large hatchery runs returning to lower river release areas or to the major hatcheries adjacent to the lower mainstem Columbia River.

Harvest impacts on Snake River fall-run chinook salmon declined after listing and have remained relatively constant at approximately 35-40% in recent years (Figure A.2.1.3). The decline and subsequent listing of Snake River fall-run chinook salmon prompted major restrictions on U. S. fisheries impacting this stock. In-river gillnet and sport fisheries are ‘shaped’ in time and space to maximize the catch of harvestable hatchery and natural (Hanford Reach) stocks while minimizing impacts on the intermingled Snake River fall-run chinook salmon. Reductions in ocean fishery impacts on Snake River fall-run chinook salmon resulted from management measures designed to protect weakened or declining stocks specific to each set of fisheries.

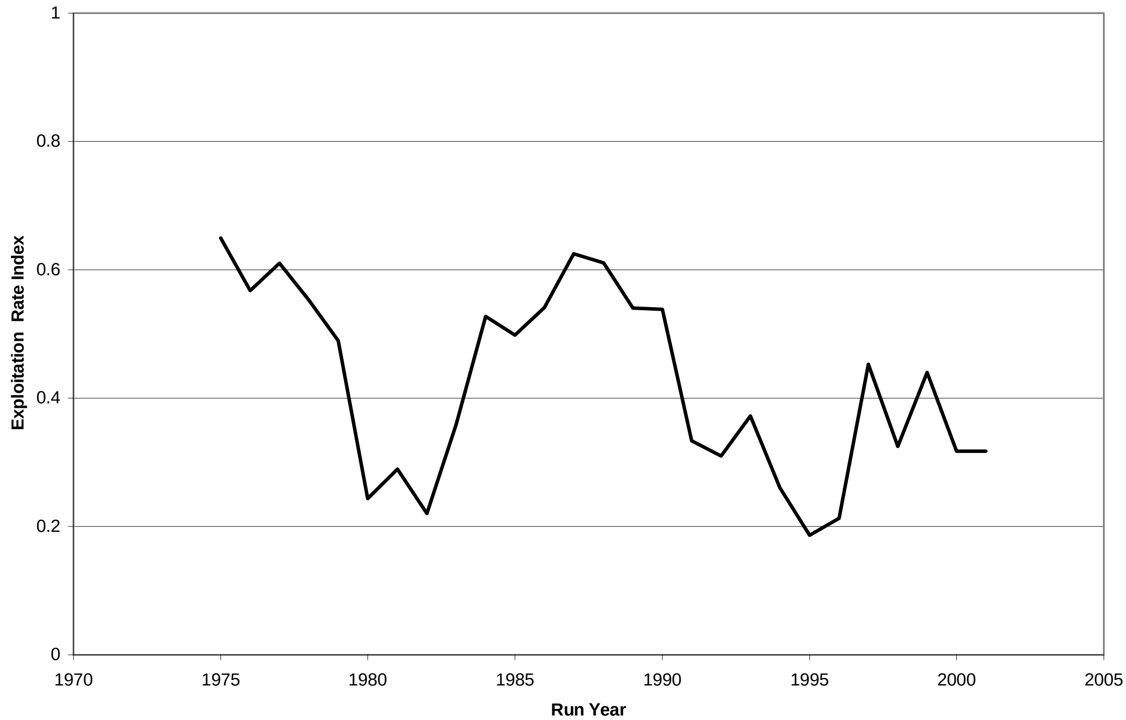

Figure A.2.1.3. Aggregate (ocean and in-river fisheries) exploitation rate index for Snake River fall chinook. Data from Marmorek et al. 1998; 1998-2001 data from Columbia River TAC data base (Henry Yuen, pers. comm..).

Mainstem hydropower impacts

Migration conditions for subyearling chinook salmon from the Snake River have generally improved since the early 1990s (FCRPS 2000 Biological Opinion). The lack of baseline data prior to the mid-1990s precludes quantifying the changes.

Habitat

There have been no major changes in available habitat for Snake River fall-run chinook salmon since the previous status review.

A.2.1.5 New Hatchery Information

Hatchery/Natural composition

The composition of the fall chinook run at Lower Granite Dam is determined by sampling marked returns. Since the early 1980s, the run has consisted of three major components: unmarked returns of natural origin, marked returns from the Lyons Ferry Hatchery program, and strays from hatchery programs outside of the mainstem Snake River (Table A.2.2). While all three components of the fall run have increased in recent years, returns of Snake River origin chinook salmon have increased disproportionately to outside hatchery strays. Prior to the 1998/99 status reviews, the five-year average contribution of outside stocks to the escapement over Lower Granite Dam exceeded 26.2%. The most recent five-year average (1997-2001) was 12.4%, with the contribution in 2001 being just over 8%. The drop in relative contribution by outside stocks reflects the disproportionate increase in returns of the Lyons Ferry component, the systematic removal of marked hatchery fish at the Lower Granite Dam trap, and modifications to the Umatilla program to increase homing of fall-run chinook salmon release groups intended to return to the Umatilla River.

The primary contributor of non-ESU strays to Lower Granite Dam continues to be releases from the Umatilla fall-run chinook salmon program (Priest Rapids stock). In addition, returns from the Klickitat fall-run chinook salmon releases have been consistently detected at the Lower Granite Dam adult trap. In 2000-2002, two or three adult chinook salmon with Klickitat coded wire tags were detected in each sampling year (Milks et al. 2003). Recoveries of Umatilla origin adult tags at the Lower Granite trap ranged from 43 to 166 for the same three-year period (Milks et al. 2003).

One of the concerns leading to the listing of Snake River fall-run chinook salmon under the ESA was the possibility of significant introgression due to increased straying by outside stocks into the natural spawning areas above Lower Granite Dam. Removal of all outside origin stock at Lower Granite Dam is not feasible--the trapping operation does not handle 100% of the run at the dam and outside stocks are generally not 100% marked. A genetic analysis of outmigrant smolts produced from spawning above Lower Granite Dam was conducted to evaluate the potential for introgression of outside stocks. Marshall et al. (2000) concluded that distinctive patterns of allelic diversity persisted in the stock, indicating that the natural Snake River fall-run chinook salmon run remains a distinct resource.

Categorizations of Snake River fall-run chinook salmon hatchery stocks (SSHAG 2003) can be found in Appendix A.5.1.

A.2.2 SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON

Primary contributor: Thomas Cooney
(Northwest Fisheries Science Center)

Spring and summer chinook salmon runs returning to the major tributaries of the Snake River were classified as an evolutionarily significant unit (ESU) by NMFS (Matthews and Waples 1991). This ESU includes production areas that are characterized by spring-timed returns, summer-timed returns, and combinations from the two adult timing patterns. Runs classified as spring chinook salmon are counted at Bonneville Dam beginning in early March and ending the first week of June; runs classified as summer-run chinook salmon return to the Columbia River from June through August. Returning fish hold in deep mainstem and tributary pools until late summer, when they emigrate up into tributary areas and spawn. In general, spring-run type chinook salmon tend to spawn in higher elevation reaches of major Snake River tributaries in mid- through late August, and summer-run Snake River chinook salmon spawn approximately 1 month later than spring-run fish.

Many of the Snake River tributaries used by spring and summer chinook salmon runs exhibit two major features: extensive meanders through high elevation meadowlands and relatively steep lower sections joining the drainages to the mainstem Salmon (Matthews and Waples 1991). The combination of relatively high summer temperatures and the upland meadow habitat creates the potential for high juvenile salmonid productivity. Historically, the Salmon River system may have supported more than 40% of the total return of spring-run and summer-run chinook salmon to the Columbia River system (e.g., Fulton 1968).

The Snake River spring/summer-run chinook salmon ESU includes current runs to the Tucannon River, the Grand Ronde River system, the Imnaha River and the Salmon River (Matthews and Waples 1991). The Salmon River system contains a range of habitats used by spring/summer-run chinook salmon. The South Fork and Middle Fork tributaries to the Salmon currently support the bulk of natural production in the drainage. Two large tributaries entering above the confluence of the Middle Fork, the Lemhi and Pahsimeroi Rivers, drain broad alluvial valleys and are believed to have historically supported substantial, relatively productive anadromous fish runs. Returns into the upper Salmon River tributaries have re-established following the opening of passage around Sunbeam Dam on the mainstem Salmon River downstream of Stanley, ID. Sunbeam Dam in the Upper Salmon River was a serious impediment to migration of anadromous fish and may have been a complete block in at least some years before its partial removal in 1934 (Waples, et al. 1991).

Current runs returning to the Clearwater River drainages were not included in the Snake River spring/summer-run chinook salmon ESU. Lewiston Dam in the lower main stem of the Clearwater River was constructed in 1927 and functioned as an anadromous block until the early 1940s (Matthews and Waples 1991). Spring and summer chinook salmon runs into the Clearwater system were reintroduced via hatchery outplants beginning in the late 1940s. As a result, Matthews and Waples (1991) concluded that even if a few native salmon survived the hydropower dams, “...the massive outplantings of non-indigenous stocks presumably substantially altered, if not eliminated, the original gene pool.”

Spring-run and summer-run chinook salmon from the Snake River basin exhibit stream type life-history characteristics (Healey 1983). Eggs are deposited in late summer and early fall, incubate over the following winter and hatch in late winter/early spring of the following year. Juveniles rear through the summer, overwinter and migrate to sea in the spring of their second year of life. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer rearing and/or overwintering areas. Snake River spring/summer-run chinook salmon return from the ocean to spawn primarily as 4 and 5 year old fish, after 2 to 3 years in the ocean. A small fraction of the fish return as 3-year-old ‘jacks’, heavily predominated by males.

A.2.2.1 Summary of Previous BRT Conclusions

The 1991 ESA status review (Mathews and Waples, 1991) of the Snake River spring/summer-run chinook salmon ESU concluded that the ESU was at risk based on a set of key factors. Aggregate abundance of naturally produced Snake River spring/summer-run chinook salmon runs had dropped to a small fraction of historical levels. Short-term projections (including jack counts, habitat/flow conditions in the broodyears producing the next generation of returns) were for a continued downward trend in abundance. Risk modeling indicated that if the historical trend in abundance continued, the ESU as a whole was at risk of extinction within 100 years. The review identified related concerns at the population level within the ESU. Given the large number of potential production areas in the Snake basin and the low levels of annual abundance, risks to individual subpopulations may be greater than the extinction risk for the ESU as a whole. The 1998 chinook salmon status review (Myers et al. 1998) summarized and updated these concerns. Both short and long-term abundance trends had continued downward. The report identified continuing disruption due to the impact of mainstem hydroelectric development including altered flow regimes and impacts on estuarine habitats. The 1998 review also identified regional habitat degradation and risks associated with the use of outside hatchery stocks in particular areas—specifically including major sections of the Grande Ronde River basin.

Direct estimates of annual runs of historical spring/summer-run chinook salmon to the Snake River are not available. Chapman (1986) estimated that the Columbia River produced 2.5 million to 3.0 million spring-run and summer-run chinook salmon per year in the late 1800s. Total spring-run and summer-run chinook salmon production from the Snake River basin contributed a substantial proportion of those returns; the total annual production of Snake River spring-run and summer-run chinook salmon may have been in excess of 1.5 million adult returns per year (Matthews and Waples 1991). Returns to Snake River tributaries had dropped to roughly 100,000 adults per year by the late 1960s (Fulton 1968). Increasing hatchery production contributed to subsequent years’ returns, masking a continued decline in natural production.

A.2.2.2 New Data and Updated Analyses

Abundance

Aggregate returns of spring-run chinook salmon (as measured at Lower Granite Dam) showed a large increase over recent year abundances (Figure A.2.2.1). The 1997-2001 geometric mean return of natural-origin chinook salmon exceeded 3,700. The increase was largely driven by the 2001 return—estimated to have exceeded 17,000 naturally produced spring chinook salmon—however, a large proportion of the run in 2001 was estimated to be of hatchery origin (88%). The summer run over Lower Granite Dam has increased as well (Figure A.2.2.2). The 1997-2001 geometric mean total return was slightly more than 6,000. The geometric mean return for the broodyears for the recent returns (1987-96) was 3,076 (Note: does not address hatchery/wild breakdowns of the aggregate run).

Returns in other production areas are shown in Figures A.2.2.3-A.2.2.16 and summarized in Table A.2.2.1. The lowest five-year geometric mean returns for almost all of the individual Snake River spring/summer-run chinook salmon production areas were in the 1990s. Sulphur Creek and Poverty Flats production areas had low five-year geometric mean returns in the early 1980s. Many, but not all, production areas had large increases in return year 2001.

Recent return levels are also compared against interim delisting criteria (abundance) for those production areas with designated levels. (Table A.2.2.1). The interim abundance criteria were suggested by the Snake River Salmon Recovery Team (Bevan et al., 1995) or, in some cases, were developed for use in analyses supporting the Federal Columbia River hydropower system Biological Opinions.

Productivity

Long-term trend and long-term λ estimates were below 1 for all natural production data sets, reflecting the large declines since the 1960s. Short-term trends and λ estimates were generally positive with relatively large confidence intervals (Table A.2.2.1 & Figure A.2.2.17). Grande Ronde and Imnaha data sets had the highest short-term growth rate estimates. Tucannon River, Poverty Flat (did not have 2000 and 2001 included) and Sulphur Creek index areas had the lowest short-term λ estimates in the series. Patterns in returns per spawners for stocks with complete age information (e.g. Minam River) show a series of extremely low return rates in the 1990s followed by increases in the 1995-97 broodyears (Figure A.2.2.18).

Hydropower impacts

Snake River spring/summer-run chinook salmon must migrate past a series of mainstem Snake and Columbia River hydroelectric dams on their migrations to and from the ocean. The Tucannon River population must migrate through six dams; all other major Snake River drainages supporting spring/summer-run chinook salmon production are above eight dams. Earlier status reviews concluded that mainstem Columbia and Snake River hydroelectric projects have resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat.

Table A.2.2.1. Summary of abundance and trend information for Snake River spring/summer-run chinook salmon relative to previous analyses. Five-year geometric means calculated using years 1997 to 2001 unless otherwise noted. Previous natural geomean for 1987-96 period. Interim targets from B. Lohn Apr. 2002 letter to NWPPC. Comparison of current (recent 5 year geometric mean) to interim target only for those production areas with estimated spawners and corresponding interim target (rpm = redds/mile).

Population(s)	**Recent 5-year geometric mean**				**Short-Term Trend (%/yr)**		**Interim Target (#'s)**	**Current vs. Interim Target**
	% Natural Origin (prev.)	**Total**	**Natural**					
		Mean (Range)	**Current**	**Previous**	**Current**	**Previous**		
Tucannon R.	24	303 (128 – 1012)	80	190	-4.1	-11.0		
Wenaha R. *	36	225 (67 – 586)	82		-9.4	-23.6		
Wallowa R.	95	0.57 redds (0.0 – 29.0)			+11.5			
Lostine R.	95	34 redds (9 – 131)			+12.7			
Minam R.	95	180 (96 – 573)	172	69	+3.3	-14.5		
Catherine Cr.*	44	50 (13 – 262)	22	45	-25.1	-22.5		
Upper Grande Ronde R.*	42	46 (3 – 336)	20		-9.4			
South Fork Salmon R.	91	496 redds (277 – 679)			+1.1	-13.6		
Secesh R.	96	144 redds (38 – 444)			+9.8			
Johnson Cr.	100	131 redds (49 – 444)[1]			-1.5			
Big Creek Springs	100	53 (21 – 296)	53		+5.4	-34.2		
Big Creek Summers	?	5 redds (2 – 58)			+1.7	-27.9		
Loon Cr.	100	27 redds (6 – 255)			+12.2			
Marsh Cr.	100	53 (0 – 164)	53		-4.0			
Bear Valley / Elk Cr.	100	266 (72 – 712)	266		+6.2			
North Fork Salmon **	?	5.6 redds (2.0 – 19.0)						

Table A.2.2.1 (continued).

Population(s)	% Natural Origin (prev.)	Recent 5-year geometric mean: Total	Natural		Short-Term Trend (%/yr)		Interim Target	Current vs. Interim Target
		Mean (Range)	Current	Previous	Current	Previous		
Lemhi R.	100	72 redds (35 – 216)			+12.8	-27.4		
Pahsimeroi R.	?	161 (72 – 1097)			+12.8			
E. Fork Springs***	?	0.27 rpm (0.2 – 1.41)			-5.7			
E. Fork Salmon Summers	100	1.22 rpm (0.35 – 5.32)			+0.9	-32.9		
Yankee Fork Springs***	?	0.0 rpm (0.0 – 0.0)			-6.3			
Yankee Fork Summers	100	2.9 redds (1.0 – 18.0)			+4.1			
Valley Cr. Springs	100	7.4 redds (2.0 – 28.0)			+14.9	-25.9		
Valley Cr. Summers****	?	2.14 rpm (0.71 – 9.29)			+5.8	-29.3		
Upper Salmon Springs	?	69 redds (25 – 357)			+5.3			
Upper Salmon Summers***	?	0.24 rpm (0.07 – 0.58)			-3.3			
Alturas Lake Cr.	?	2.7 redds (0 – 18)			+10.2			
Imnaha R.	38	564 redds (194 – 3,041)[1]		216	+12.8	-24.1		
Big Sheep Cr.	3	0.25 redds (0.0 – 1.0)			+0.8			
Lick Cr.	41	1.4 redds (0.0 – 29.0)			+11.7			

* 5 year geometric mean calculated using years 1992 – 1996
** 5 year geometric mean calculated using years 1996 – 2000
*** 5 year geometric mean calculated using years 1993 – 1997
**** 5 year geometric mean calculated using years 1997, 2000 and 2001 only
[1] Expanded redds

Harvest

Harvest impacts on Snake River spring-run chinook salmon are generally low. Ocean harvest rates are also low. Historical harvest estimates reflect the impact of mainstem and tributary in-river fisheries. In response to initial declines in returns, in-river harvests of both chinook spring-run and summer-run chinook salmon were restricted beginning in the early 1970s (Matthews and Waples 1991).

Fishery impacts were further reduced following listing in 1991, with lower harvest rates from 1991-1999. In response to the large increase in returns of spring chinook salmon runs, additional impacts were allowed beginning in 2000. The management agreement providing for increased impacts as a function of abundance also calls for additional reductions if and when runs drop back down below prescribed thresholds[2].

Habitat

Tributary habitat conditions vary widely among the various drainages of the Snake River basin. There is habitat degradation in many areas of the basin reflecting the impacts of forest, grazing and mining practices. Impacts relative to anadromous fish include lack of pools, increased water temperatures, low flows, poor overwintering conditions, and high sediment loads. Substantial portions of the Salmon River drainage, particularly in the Middle Fork, are protected in wilderness areas.

A.2.2.5 New Hatchery Information

Hatchery production

Spring-run and summer-run chinook salmon are produced from a number of artificial production facilities in the Snake River basin (Table A.2.2.2). Much of the production was initiated under the Lower Snake River Compensation Plan. Lyons Ferry Hatchery serves as a rearing station for Tucannon spring-run chinook salmon broodstock. Rapid River Hatchery and McCall Hatchery provide rearing support for a regionally derived summer-run chinook salmon broodstock released into lower Salmon River areas. Two major hatchery programs have operated in the upper Salmon basin—the Pahsimeroi and Sawtooth facilities. Since the mid-1990s, small-scale natural stock supplementation studies and captive breeding efforts have been initiated in the Snake River basin.

Historically, releases from broodstock originating outside of the basin have constituted a relatively small fraction of the total release into the basin. The 1998 chinook salmon status review (Myers et al. 1998) identified concerns regarding the use of the Rapid River Hatchery stock reared at Lookingglass Hatchery in the Grande Ronde River basin. The Rapid River stock was originally developed from broodstock collected from the spring-run chinook salmon returns to historical production areas above the Hells Canyon complex.

[2] Order Approving Interim Management Agreement for Upriver Spring chinook, Summer Chinook and Sockeye. Approved April 5, 2001. U.S. v Oregon. Civil -68-513.

Use of the Rapid River stock in Grande Ronde drainage hatchery programs has been actively phased out since the late 1990s. In addition, a substantial proportion of marked returns of Rapid River stock released in the Grande Ronde have been intercepted and removed at the Lower Granite Dam ladder and at some tributary level weirs. Carcass survey data indicate significant declines in hatchery contributions to natural spawning in areas previously subject to Rapid River stock strays.

Concerns for the high incidence of BKD disease in Snake River basin hatchery facilities were also identified (Myers et al. 1998).

Categorization of Snake River spring/summer-run chinook salmon hatchery stocks (SSHAG 2003) can be found in Appendix A.5.1.

Table A.2.2.2. Total hatchery releases of spring and summer chinook into the Snake River Basin. Summarized by stock and release site. Information from Fish Passage Center smolt release data base.

Basin	Stock	Average releases per year		
		1985 - 1989	1990 - 1994	1995 - 2001
Mainstem Snake	Rapid River	405,192	445,411	146,728
	Leavenworth	32,857	-	-
	Lookingglass	-	-	20,622
	Mixed	-	-	29,369
	Mainstem Total	**438,049**	**445,411**	**196,719**
Tucannon	Tucannon River	63,733	108,957	93,742
Mainstem Grande Ronde	Carson	784,785	100,934	-
	Imnaha River	24,700	-	-
	Lookingglass	396,934	-	-
	Rapid River	452,786	642,605	239,756
	Grande Ronde River	-	-	581
Catherine Creek	Carson	60,893	-	-
	Rapid River	-	14,000	-
	Catherine Creek	7,552	-	24,973
	Lookingglass	153,420	-	-
Wallowa	Carson	70,529	-	-
	Lookingglass	55,120	-	-
	Lostine River	-	-	25,847
	Rapid River	-	28,863	-
	Grande Ronde Total	**2,006,718**	**786,401**	**291,158**
Little Salmon	Rapid River	2,374,325	2,631,741	1,552,835
South Fork Salmon	South Fork Salmon River	929,351	1,020,393	888,469
Pahsimeroi	Pahsimeroi River	418,160	479,382	74,934
	Salmon River	55,809	-	40,444
East Fork Salmon	Salmon River	182,598	147,614	6,222
Upper Salmon	Pahsimeroi River	145,100	-	-
	Rapid River	10,020	20,000	-
	Salmon River	1,220,188	1,091,576	96,877
	Salmon River Total	**5,335,551**	**5,390,706**	**2,659,782**
Imnaha	Imnaha River	**98,425**	**339,928**	**269,886**
ESU Total	**All Stocks**	**7,942,476**	**7,071,402**	**3,511,286**

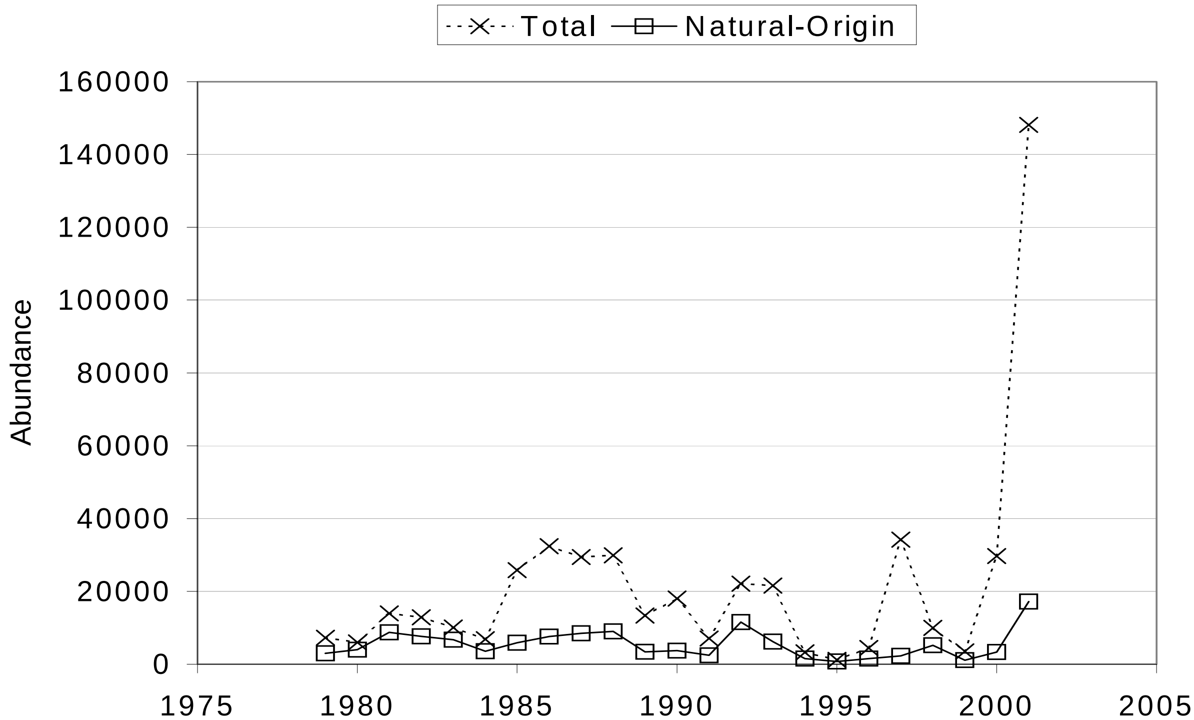

Figure A.2.2.1. Snake River spring-run chinook salmon escapement over Lower Granite Dam.

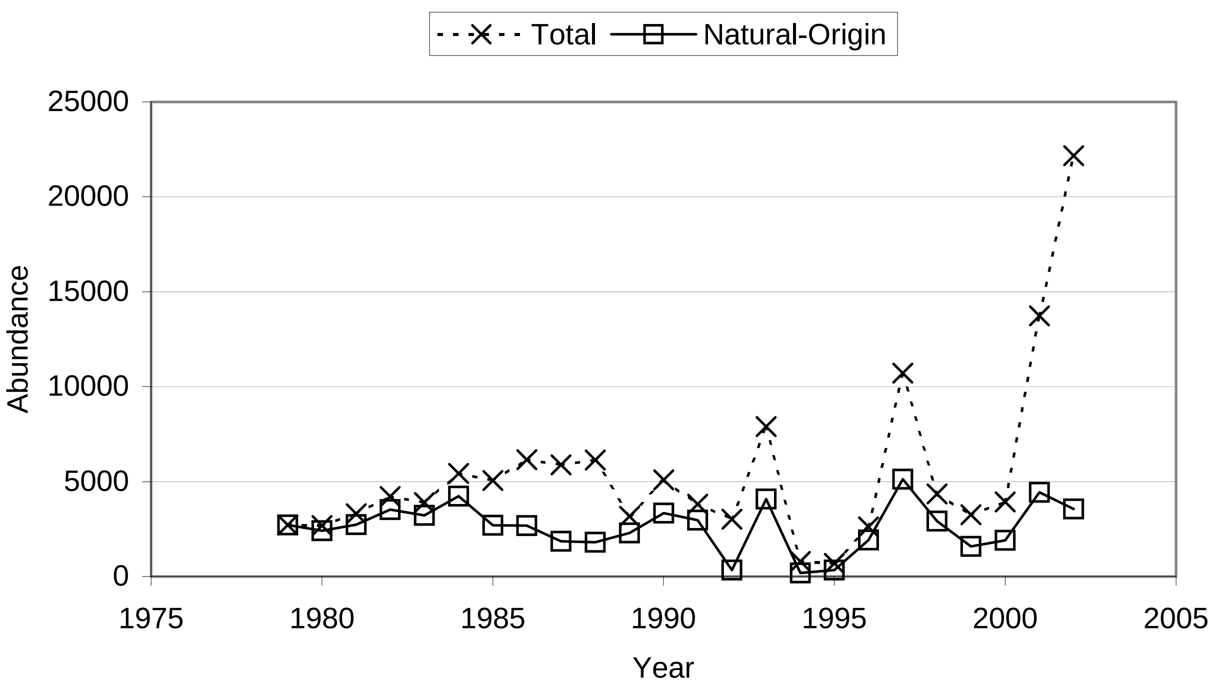

Figure A.2.2.2. Snake River summer-run chinook salmon escapement.

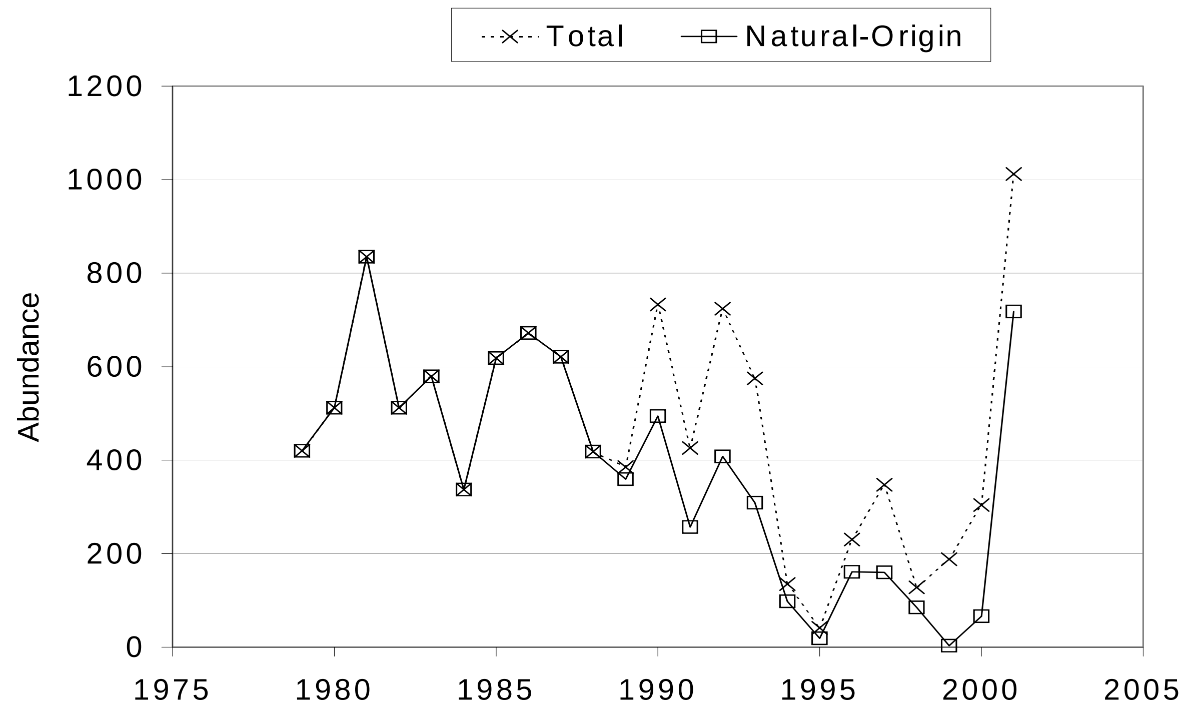

Figure A.2.2.3. Tucannon River spring-run chinook salmon spawning escapement; estimates based on trap counts and expanded redd estimates (WDFW).

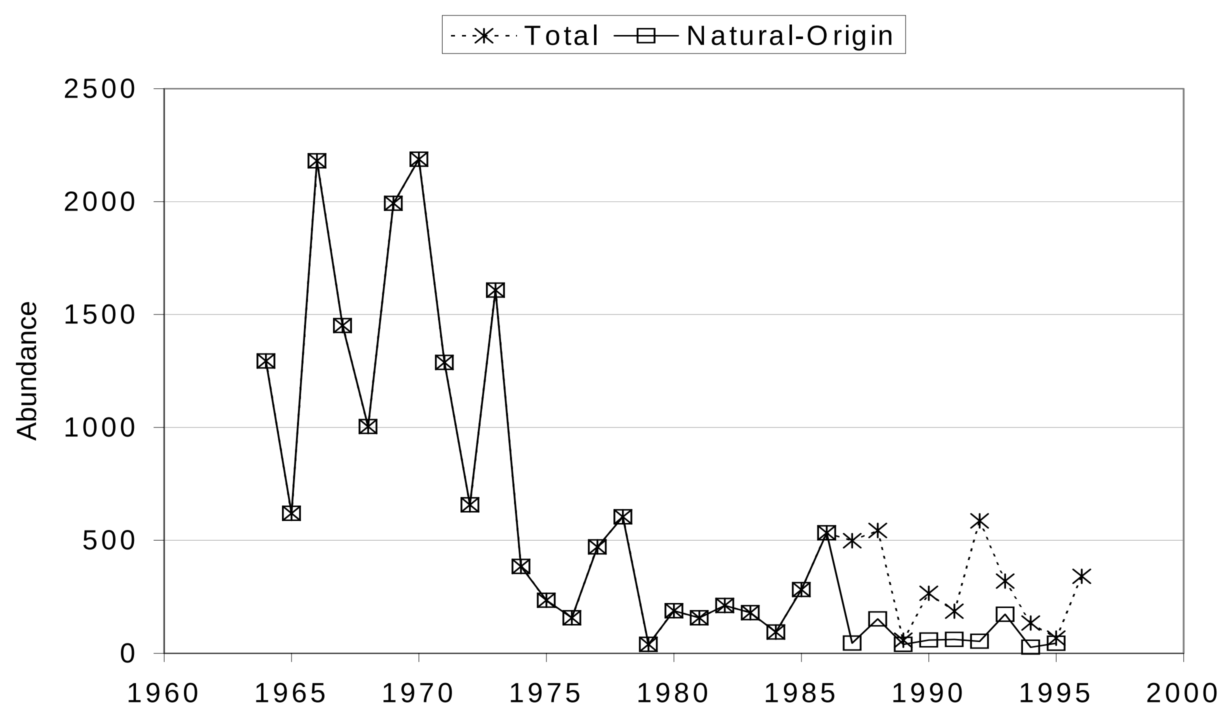

Figure A.2.2.4. Wenaha River spring-run chinook spawning escapement; estimates expanded from redd counts.

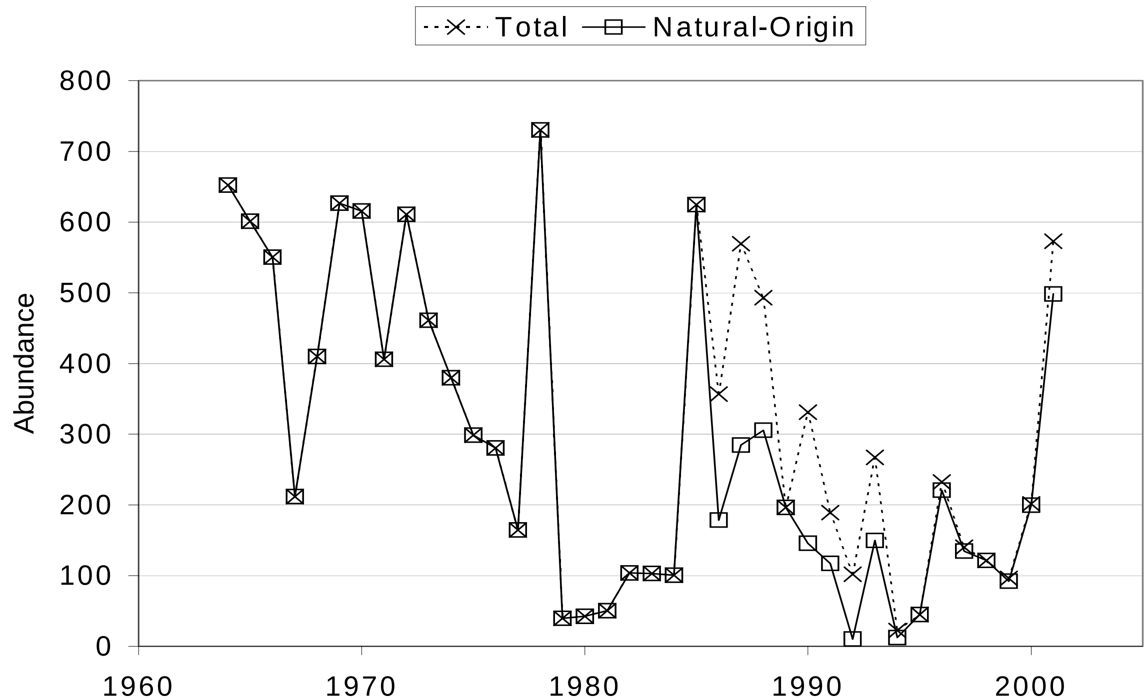

Figure A.2.2.5. Minam River chinook salmon spawning escapements; estimates based on expanded redd counts and carcass sampling (ODFW).

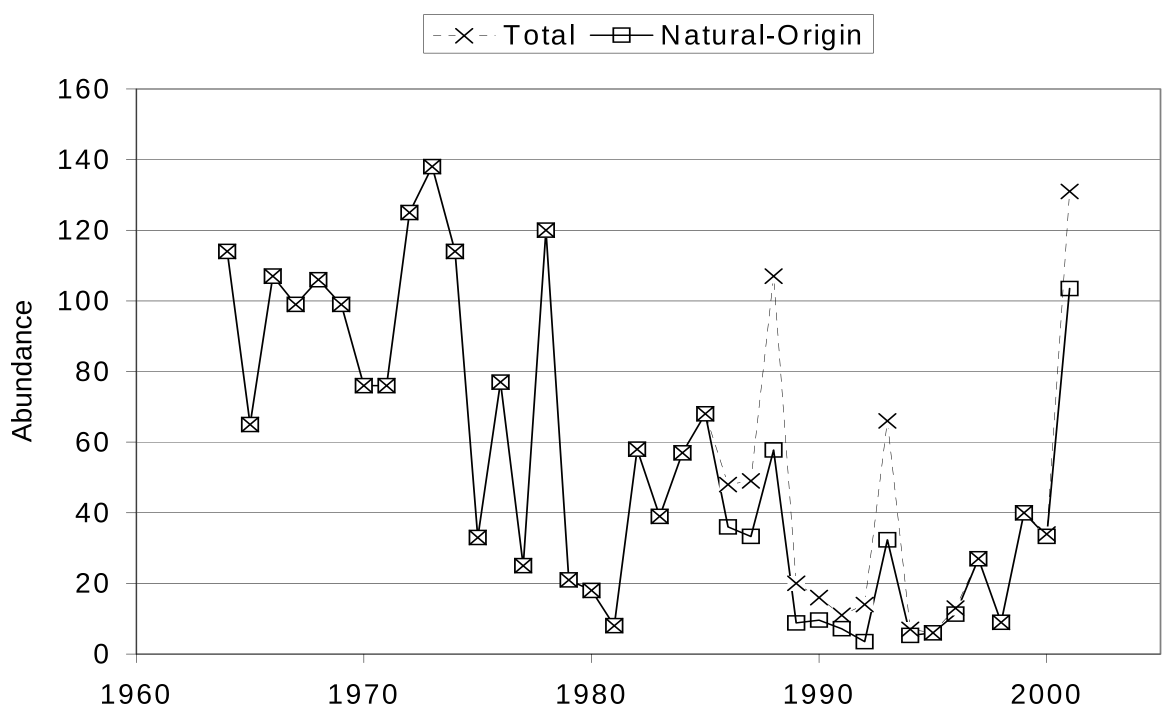

Figure A.2.2.6. Lostine River spring-run chinook salmon total counts; estimates based on redd count expansions and carcass sampling (ODFW).

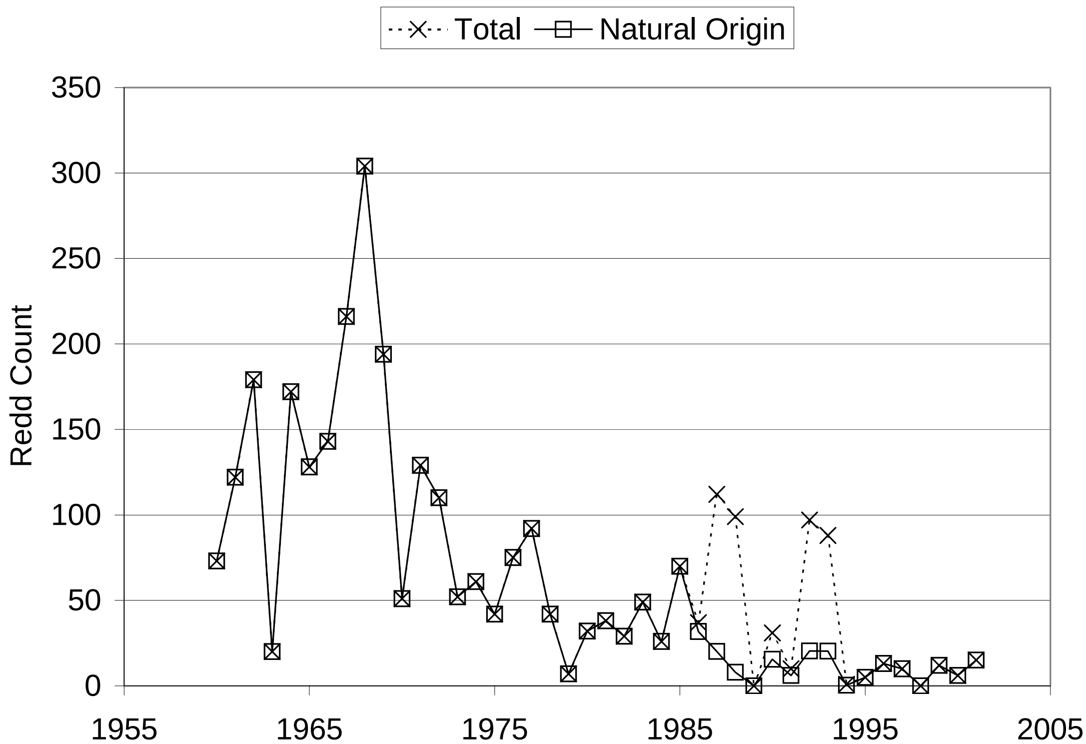

Figure A.2.2.7. Upper Grande Ronde River spring-run chinook redd counts; hatchery contributions based on carcass sampling (ODFW).

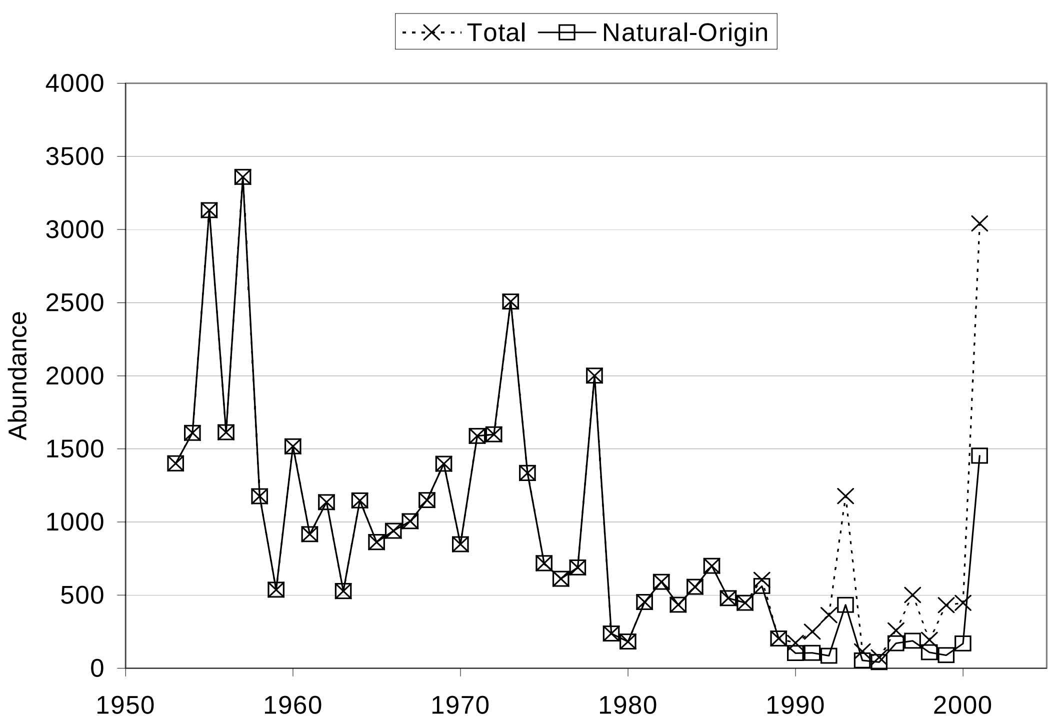

Figure A.2.2.8. Imnaha River spring-run chinook salmon spawning escapement; estimates based on expanded redd counts and carcass sampling (ODFW).

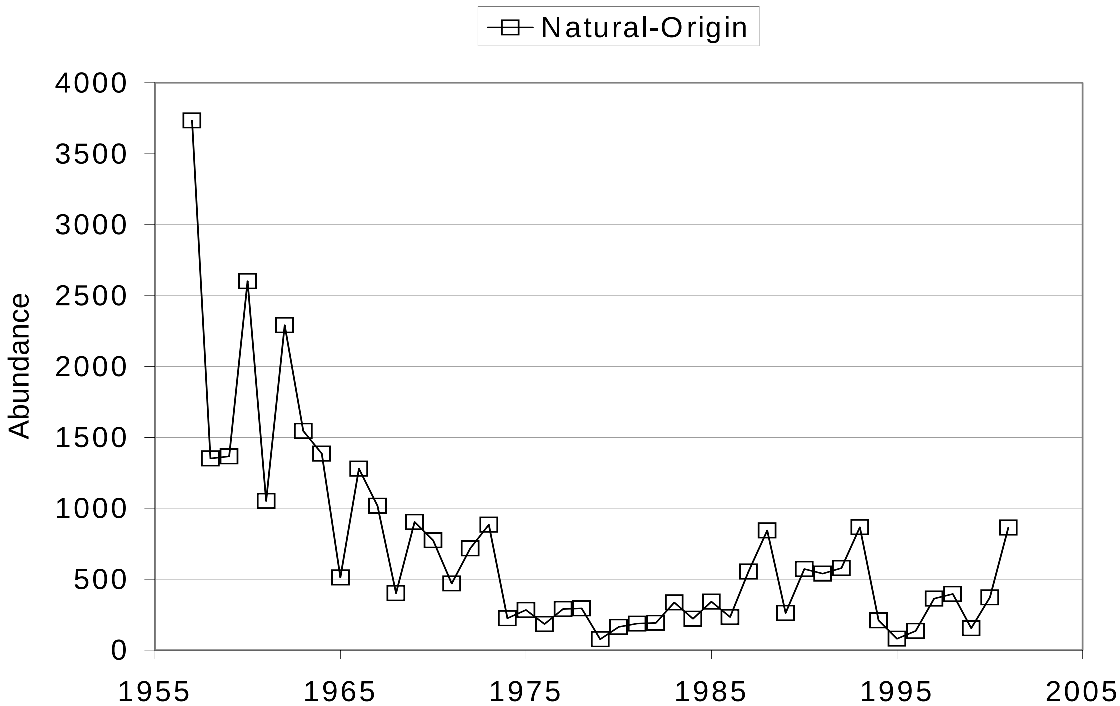

Figure A.2.2.9. Poverty Flat summer-run chinook salmon spawning escapement; estimates based on Idaho Department of Fish and Game (IDFG) redd count expansions.

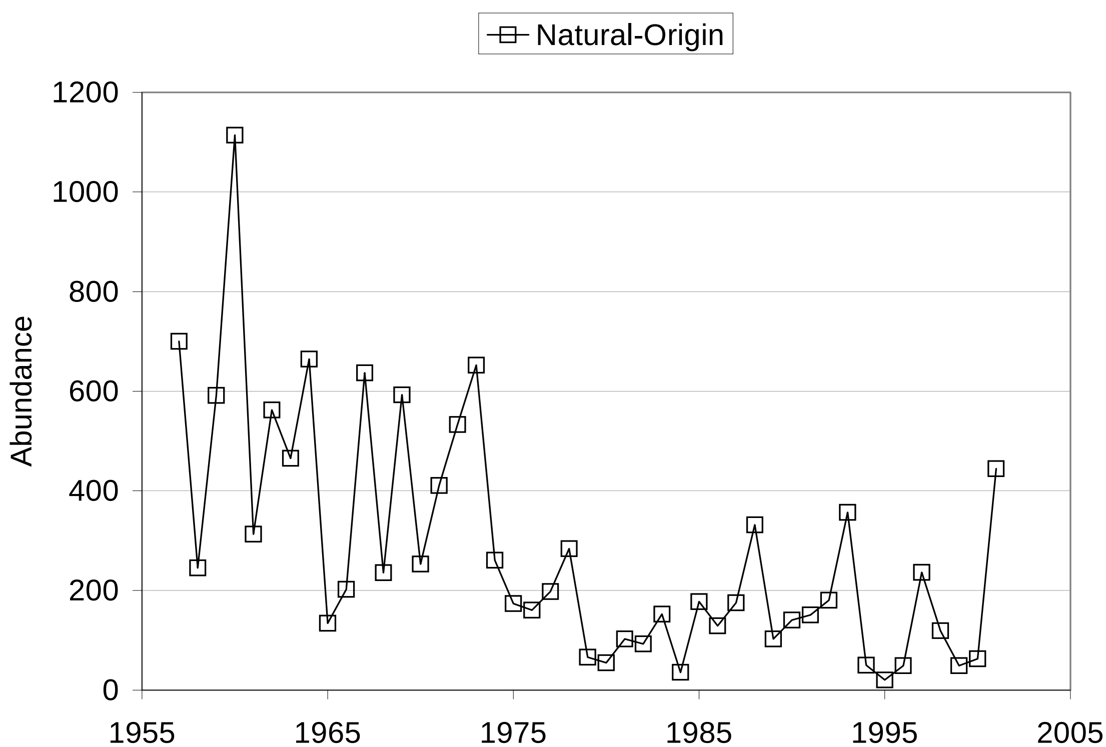

Figure A.2.2.10. Johnson Creek summer-run chinook salmon spawning escapement; estimates based on expanded redd counts (IDFG).

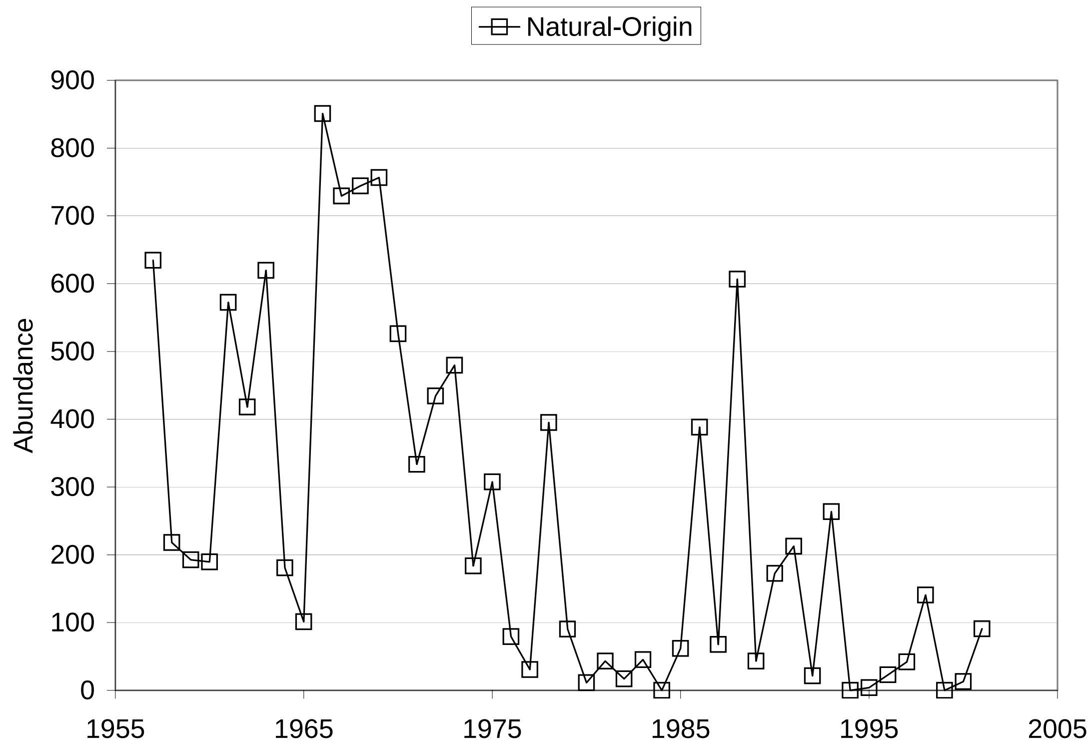

Figure A.2.2.11. Sulphur Creek spring-run chinook salmon spawning escapement; estimates based on expanded redd counts and carcass surveys (IDFG).

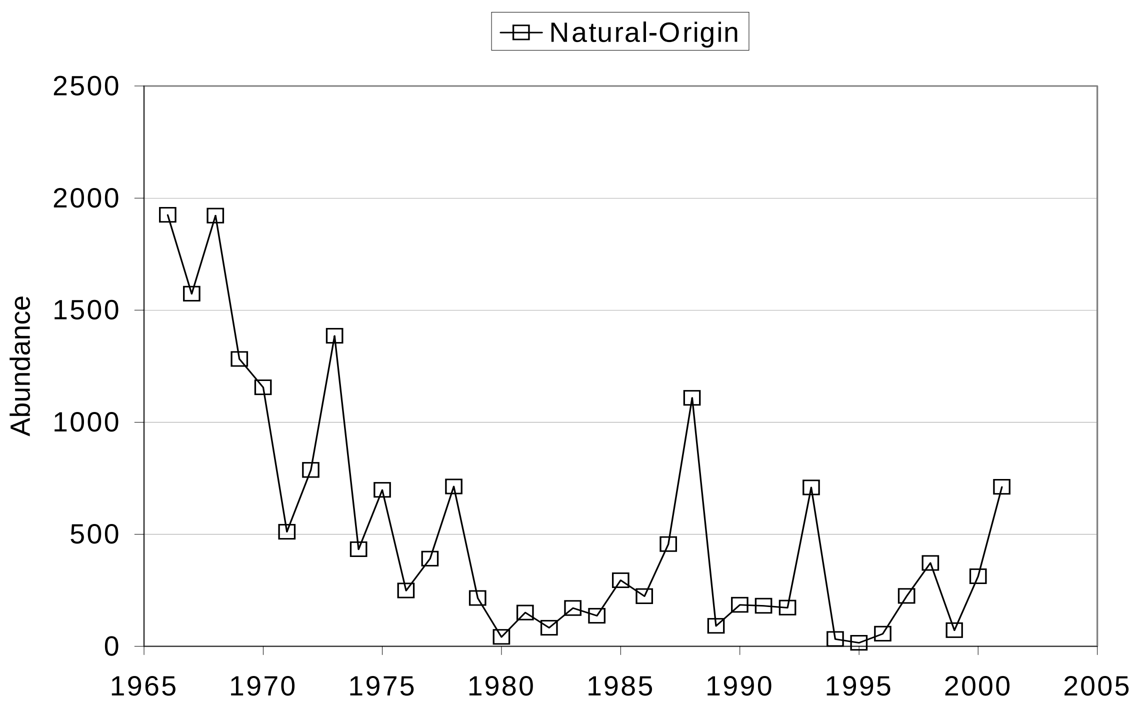

Figure A.2.2.12. Bear Valley/Elk Creek spring chinook spawning escapement; estimates based on expanded redd counts and carcass surveys (IDFG).

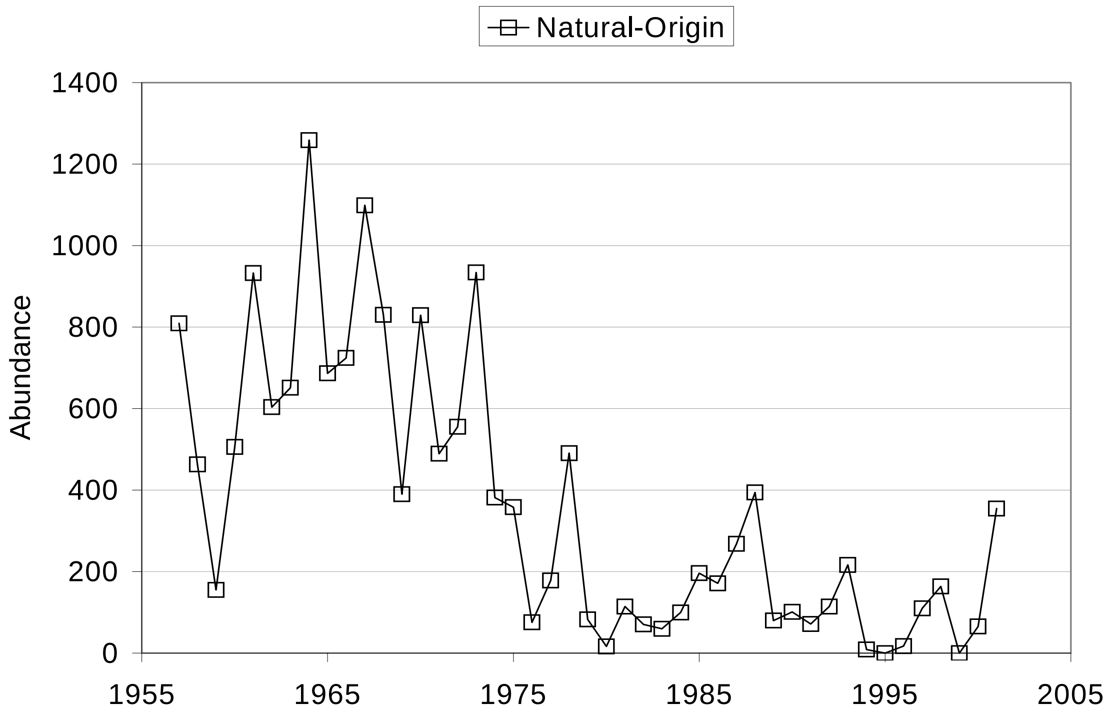

Figure A.2.2.13. Marsh Creek spring-run chinook salmon spawning escapement; estimates based on expanded redd counts and carcass sampling.

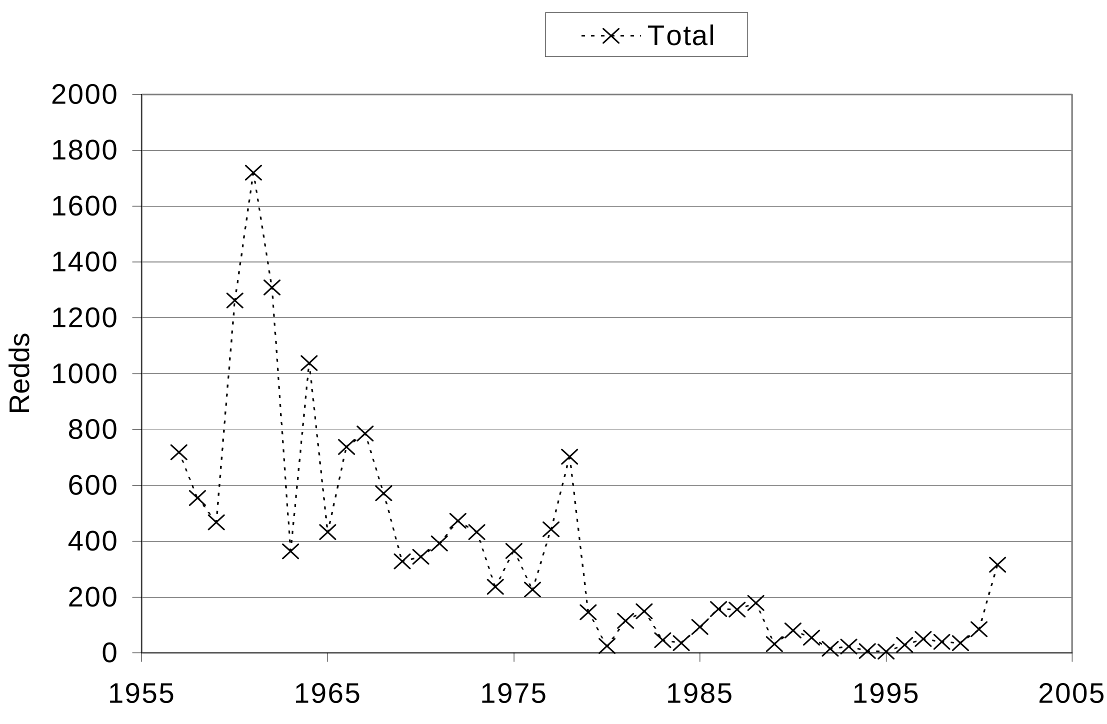

Figure A.2.2.14. Total redd count in the Lemhi River (includes hatchery and natural returns).

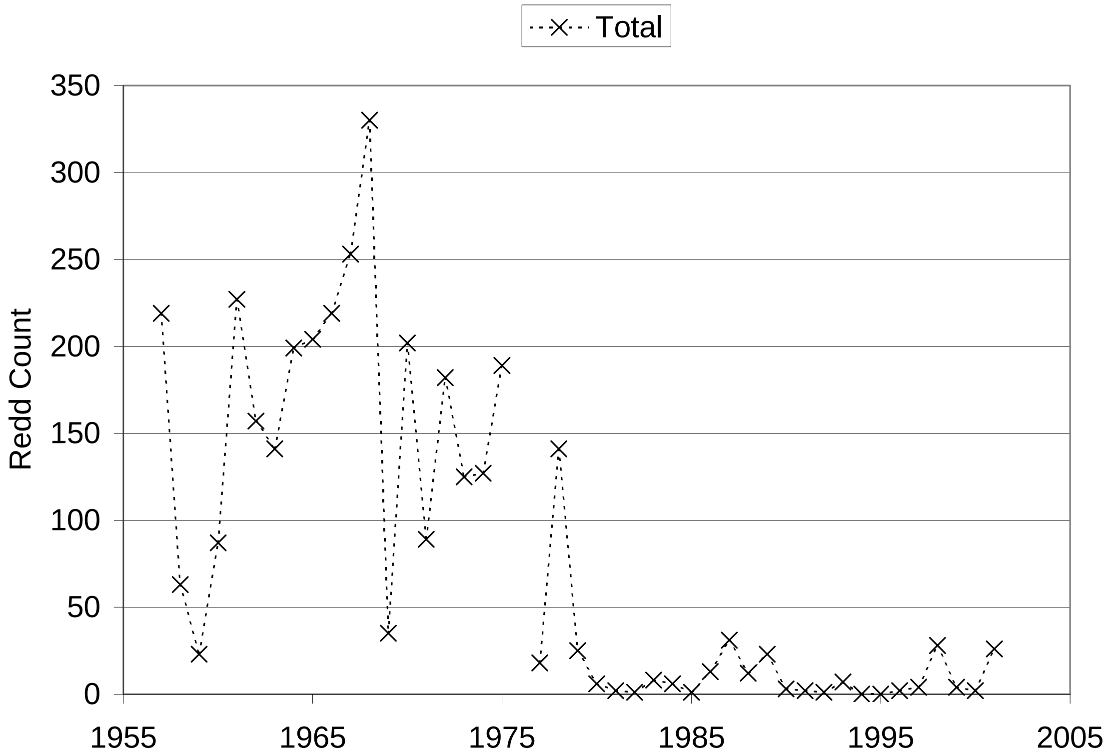

Figure A.2.2.15. Upper Valley Creek spring-run chinook salmon redd counts.

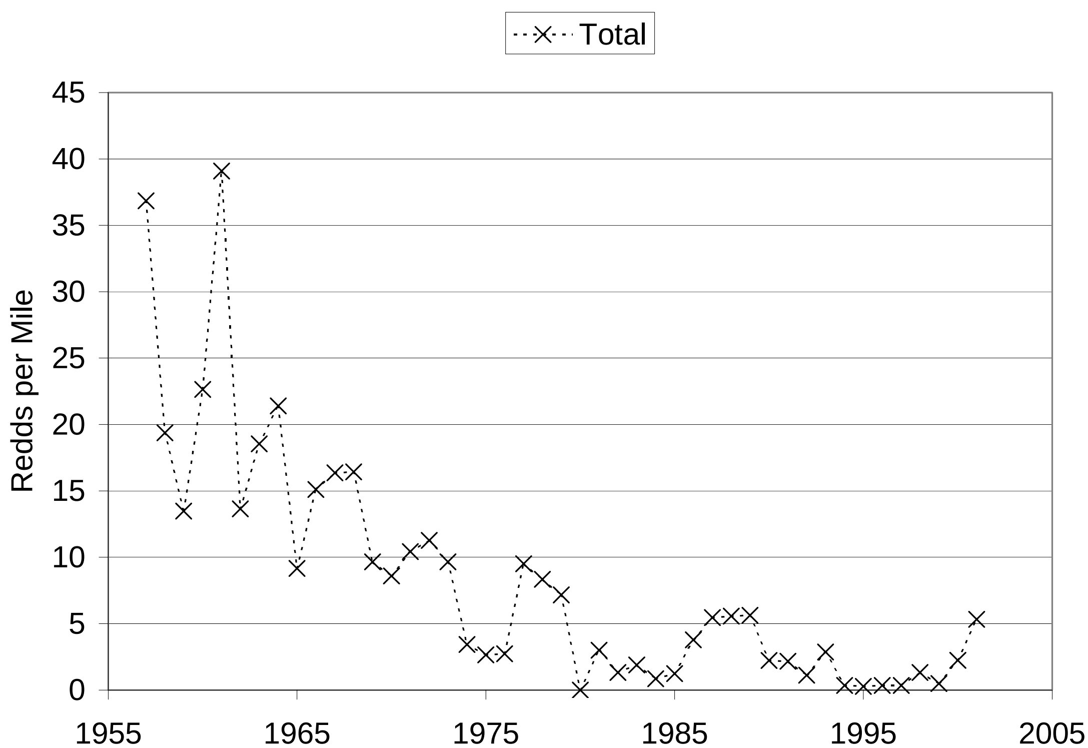

Figure A.2.2.16. East Fork Salmon summer-run chinook salmon redds/mile.

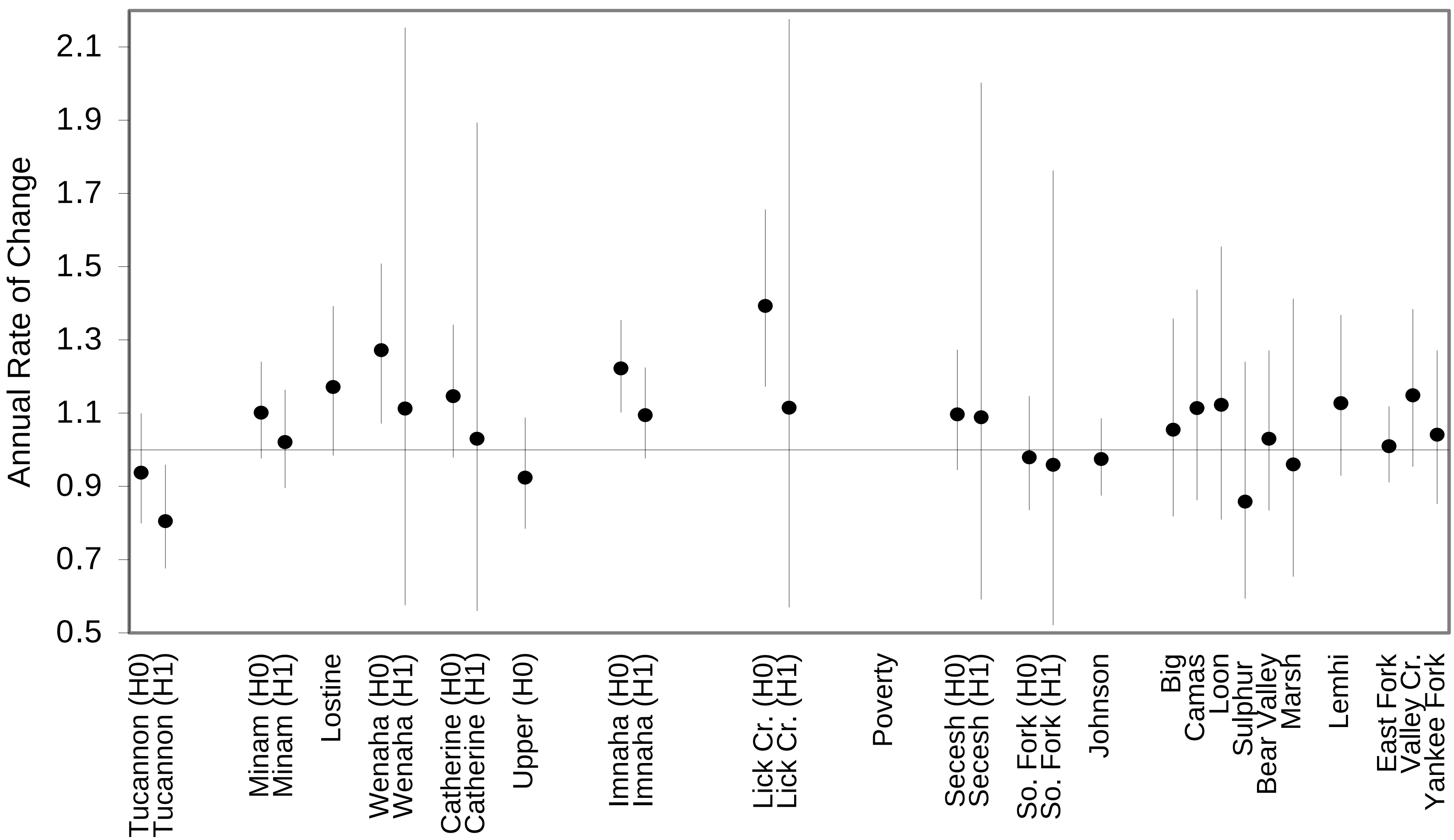

Figure A.2.2.17. Short-term median growth rate (1990-2001) for total spawners for Snake River spring/summer-run production areas. Error bars represent 95% confidence limits of the trend (H0 – hatchery-origin spawners are assumed to have zero reproductive success; H1 – hatchery-origin spawners are assumed to have the same reproductive success as natural-origin fish).

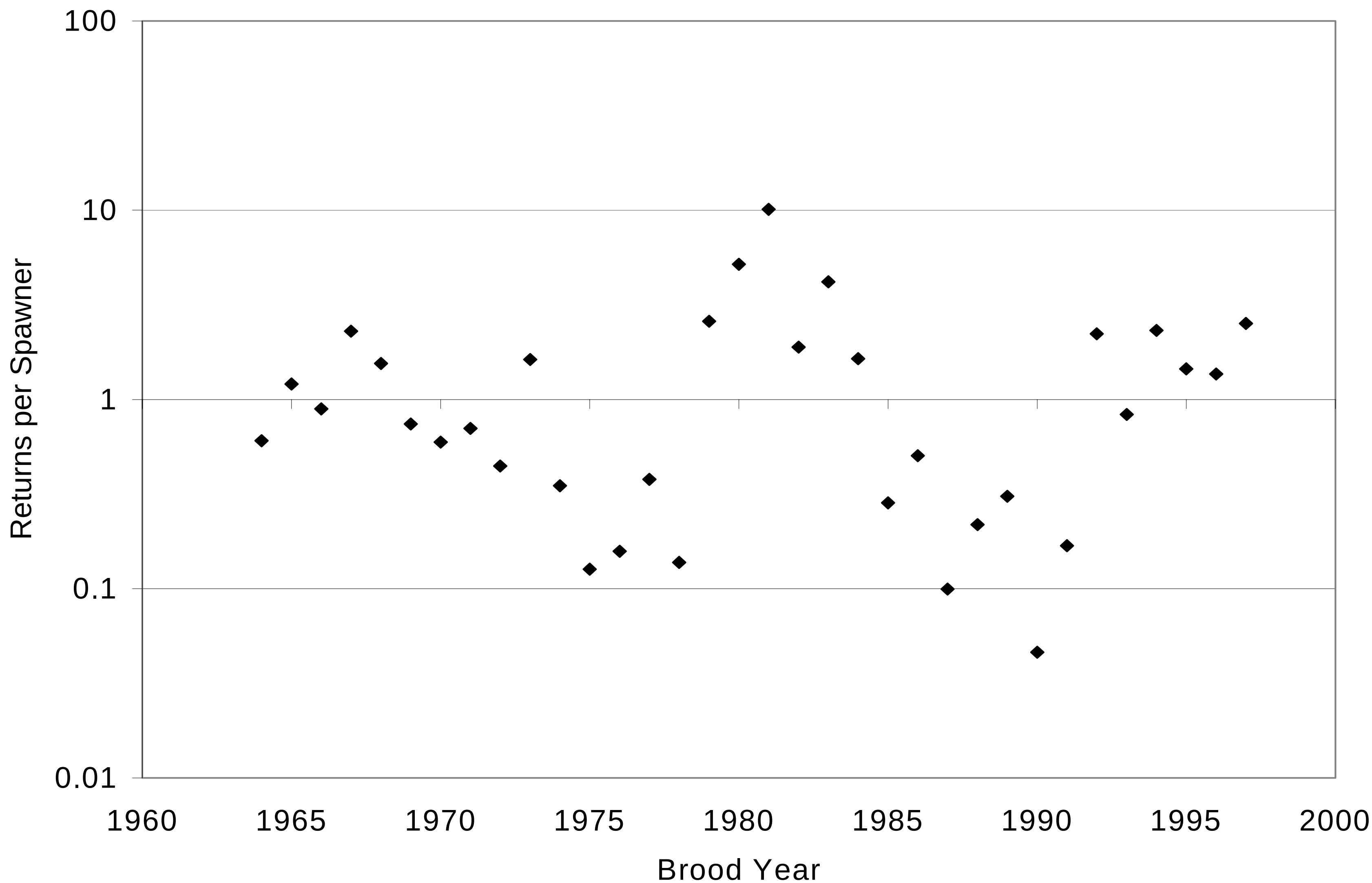

Figure A.2.2.18. Spring/summer chinnok salmon return per spawner for Minam River, calculated as estimated natural returns to the spawning grounds divided by brood year total spawners.

A.2.3 UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON

Primary contributor: Thomas Cooney
(Northwest Fisheries Science Center)

There are no estimates of historical abundance specific to this ESU prior to the 1930s. The drainages supporting this ESU are all above Rock Island Dam on the upper Columbia River. Rock Island Dam is the oldest major hydroelectric project on the Columbia River; it began operations in 1933. Counts of returning chinook salmon have been made since the 1930s. Annual estimates of the aggregate return of spring-run chinook salmon to the upper Columbia River are derived from the dam counts based on the nadir between spring and summer return peaks. Spring-run chinook salmon currently spawn in three major drainages above Rock Island Dam--Wenatchee, Methow and Entiat Rivers. Historically, spring-run chinook salmon may have also used portions of the Okanogan River.

Grand Coulee Dam, completed in 1938, formed an impassable block to the upstream migration of anadromous fish. Chief Joseph Dam was constructed on the mainstem Columbia River downstream from Grand Coulee Dam and is also an anadromous block. There are no specific estimates of historical production of spring-run chinook salmon from mainstem tributaries above Grand Coulee Dam. Habitat typical of that used by spring-run chinook salmon in accessible portions of the Columbia River basin is found in the middle/upper reaches of mainstem tributaries above Grand Coulee Dam. It is possible that the historical range of this ESU included these areas; alternatively, fish from the upper reaches of the Columbia River may have been in a separate ESU.

Artificial production efforts in the area occupied by the Upper Columbia River spring-run chinook salmon ESU extend back to the 1890s. Hatchery efforts were initiated in the Wenatchee and Methow systems to augment catches in response to declining natural production (e.g., Craig and Soumela 1941). While there are no direct estimates of adult production from early efforts, it is likely contributions were small.

In the late 1930s, the Grand Coulee Fish Maintenance Program (GCFMP) was initiated to address the fact that the completion of the Grand Coulee dam cut off anadromous access above site of the dam. Returning salmonids, including spring-run chinook salmon, were trapped at Rock Island Dam and either transplanted as adults or released as juveniles into selected production areas within the accessible drainages below Grand Coulee Dam. Nason Creek in the Wenatchee system was a primary adult transplantation area in this effort. The program was conducted annually from 1938 until the mid-1940s.

A.2.3.1 Summary of Previous BRT Conclusions

Previous BRT Review

The Upper Columbia River spring-run chinook salmon ESU was reviewed by the BRT in late 1998 (NMFS 1998). “The BRT was mostly concerned about risks falling under the abundance/distribution and trends/productivity risk categories for the ESU...average recent escapement to the ESU has been less than 5,000 hatchery plus wild chinook salmon, and individual populations all consist of less than 100 fish. The BRT was concerned that at these population sizes, negative effects of demographic and genetic stochastic processes are likely to occur. Furthermore, both long- and short-term trends in abundance are declining, many strongly so." The BRT noted that the implementation of emergency natural broodstocking and captive broodstocking efforts for the ESU "...indicate(s) the severity of the population declines to critically small sizes." The BRT recognized that "(h)abitat degradation, blockages and hydrosystem passage mortality all have contributed to the significant declines in this ESU."

A.2.3.2 New Data and Updated Analyses

WDFW, the Yakima Tribe and the Fish and Wildlife Service conduct annual redd count surveys in nine selected production areas within the geographical area encompassed by this ESU (Mosey and Murphy 2002, Hubble and Crampton 2000, Carie 2000). Prior to 1987, redd count estimates were single-survey peak counts. From 1987 on, annual redd counts are generated from a series of on-the-ground counts and represent the total number of redds constructed in any particular year. The agencies use annual dam counts from the mainstem Mid-Columbia River dams as the basis for expanding redd counts to estimates of total spring-run chinook salmon returns. In theWenatchee basin, video counts at Tumwater Dam are available for recent years. Returns to hatchery facilities are subtracted from the dam counts prior to the expansion. Updated returns are summarized in Table A.2.3.1 and in Figures (A.2.3.1-A.2.3.6).

An initial set of population definitions for Upper Columbia River spring-run chinook salmon ESU along with basic criteria for evaluating the status of each population were developed using the Viable Salmonid Population (VSP) guidelines described in McElhany et al. (2000). The definitions and criteria are described in Ford et al. (2000) and have been used in the development and review of Mid-Columbia River PUD plans and the FCRPS Biological Opinion. The interim definitions and criteria are being reviewed as recommendations by the Interior Columbia Technical Recovery Team. Briefly, the joint technical team recommended that the Wenatchee River, the Entiat River and the Methow River be considered as separate populations within the Upper Columbia River Steelhead ESU. The historical status of spring-run chinook salmon production in the Okanogan River is uncertain. The committee deferred a decision on the Okanogan to the Technical Recovery Team. Abundance, productivity and spatial structure criteria for each of the populations in the ESU were developed and are described in Ford et al. (2001).

A.2.3.3 New Hatchery Information

Three national fish hatcheries operated by the U. S. Fish and Wildlife Service are located within the geographic area associated with this ESU. These hatchery programs were established as mitigation programs for the construction of Grand Coulee Dam. Leavenworth National Fish Hatchery, located on Icicle Creek, a tributary to the Wenatchee River system (rkm 42), has released chinook salmon since 1940. Entiat National Fish Hatchery is located on the Entiat River, approximately 10 km upstream of the confluence with the Columbia River mainstem. Spring-run chinook salmon have been released from this facility since 1974. Winthrop National Fish Hatchery is on the Methow River main stem, approximately 72 km upstream of the confluence with the Columbia River. Spring-run chinook salmon were released from 1941-1961, and from 1974 to the present. Initial spring-run chinook salmon releases from these facilities were for the GCFMP project. Leavenworth Hatchery returns served as the principle stock source for all three facilities until the early 1990s. Production was augmented with eggs transferred into the programs from facilities outside of the ESU, primarily Carson Hatchery. Broodstocking for each hatchery program has been switched to emphasize locally returning broodstocks. Management objectives for the Winthrop National Fish Hatchery have been modified to this conservation strategy. The Entiat and Leavenworth Hatchery programs retain the original harvest augmentation objectives, but are managed to restrict interactions with natural populations. Carcass surveys and broodstocking efforts in the upstream natural spawning areas of the Wenatchee River and the Entiat River support the assumption that the stray rate from the downstream hatchery facilities is low—on the order of 1%-5%. Significantly higher contribution rates have been observed in mainstem Methow natural spawning areas, possibly due to the close proximity of the hatchery and to the recent shift to locally adapted stocks.

Additional spring-run chinook salmon hatchery production efforts were initiated in the 1980s as mitigation for smolt losses at mainstem mid-Columbia River projects operated by public utility districts. These programs are aimed at directly supplementing targeted natural production areas in the Wenatchee and Methow River systems. In the Wenatchee River drainage, this program has targeted the Chiwawa River, a major spring chinook production tributary entering at rkm 78.2. Broodstock are collected at a weir located approximately 2 km upstream of the mouth of the Chiwawa River. In some years broodstocking has been augmented by using marked adults collected at Tumwater Dam. Release groups are returned to an acclimation pond adjacent to the lower Chiwawa River for final acclimation and release.

In the Methow River, the supplementation program began in 1992 with broodstock collected from the natural runs to the Chewuch and Twisp Rivers. The Methow Fish Hatchery operated by WDFW has actively managed broodstock collection and mating to maintain separate groups for use in the Chewuch, Twisp and Methow Rivers. In 1996 and again in 1998, extremely low adult returns led to a decision to collect all adults at Wells Dam. Scale reading, elemental scale analysis, and extraction/reading of coded-wire tags have been used at the Methow National Fish Hatchery in support of maintaining broodstock separation.

Beginning in 1998, a composite stock was initiated and the management objectives for Winthrop National Fish Hatchery were established. Since that time, Methow and Winthrop Hatcheries have worked together on broodstock collection and spawning activities. Juveniles are reared at the Winthrop Facility and released into the mainstem Methow River in coordination with releases from acclimation sites on the Twisp River and Chewuch River. The Methow program was initiated with Winthrop Hatchery stock and is being converted to local broodstock. These supplementation programs have had two major impacts on natural production areas. Returns to natural spawning areas have included increasing numbers of supplementation fish in recent years, especially in the Methow mainstem spawning areas adjacent to the hatchery.

The WDFW SASSI report identified nine stocks of spring-run chinook salmon within the upper Columbia River spring-run chinook salmon ESU. Ford et al. (2001) describes the results of applying the population definition and criteria provided in McElhany et al. (2000) to current upper Columbia springRiver spring-run chinook salmon production. The conclusions of the effort were that "...there are (or historically were) three or four independent viable populations of spring-run chinook salmon in the upper Columbia River basin, inhabiting the Wenatchee, Entiat, Methow and (possibly) the Okanogan River basins. There appears to be considerable population substructure within the Wenatchee and Methow basins, however, this substructure should be considered when evaluating recovery goals and management actions."[3]

Hatchery impacts

Hatchery impacts vary among the production areas. Large on-station production programs in the Wenatchee and Entiat River drainages are located in the lower reaches, some distance downstream of natural spawning areas. In the Methow River, Winthrop National Fish Hatchery is located upstream, adjacent to a portion of the mainstem spawning reach for spring-run chinook salmon and steelhead. Straying of returning hatchery-origin adults into the natural production areas is thought to be low for the Wenatchee River and Entiat River. The supplementation programs in the upper Wenatchee and the Methow River basins are designed to specifically boost natural production. In years when the return of natural-origin adults is extremely low, the proportion of hatchery-origin adults on the spawning grounds can be high, even if the dispersal rate of the returning hatchery fish is low. It is likely that returning hatchery fish contribute to spawning in natural production areas in the Methow River at a higher rate. Carcass sampling data are available for a limited number of year/area combinations for the upper Columbia River drainages (e.g., WDF 1992).

Spring-run chinook salmon returns to the Wenatchee and the Methow River systems have included relatively large numbers of supplementation program fish in recent years. The total return to natural spawning areas in the Wenatchee River system for 2001 is estimated to be approximately 4,000-1,200 returning from natural spawning and 2,800 from the hatchery-based supplementation program. The return to spawning areas for the Methow in 2001 is estimated at well over 9,000. Carcass surveys indicate that returning supplementation adults accounted for approximately 80% of the 2001 run to the Methow spawning areas. Supplementation programs have contributed substantially to getting fish on the spawning grounds in recent years. Little information is available to assess the long-term impact of high levels of supplementation on productivity. Categorization for Upper Columbia River spring-run chinook salmon hatchery stocks (SSHAG 2003) can be found in Appendix A.5.1.

A.2.3.4 Comparison with Previous Data

All three of the existing upper Columbia River spring-run chinook salmon populations have exhibited similar trends and patterns in abundance over the past 40 years. The 1998 Chinook salmon status review (Myers et al. 1998) reported that long-term trends in abundance for upper Columbia River spring-run chinook salmon populations were generally negative, ranging from -5% to +1%. Analyses of the data series, updated to include 1996-2001 returns, indicate that those trends have continued. The long-term trend in spawning escapement is

[3]Spring chinook spawning in Icicle Creek, Peshastin Creek, Incgalls Creek and the Leavenworth Hatchery are considered an independent, hatchery-derived population that is not part of the ESU (NMFS 1999).

downward for all three systems. The Wenatchee River spawning escapements have declined an average of 5.6% per year, the Entiat River population at an average of 4.8%, and the Methow River population an average rate of 6.3% per year since 1958. These rates of decline were calculated from the redd count data series[4].

Mainstem spring-run chinook salmon fisheries harvested chinook salmon at rates between 30%-40% per year through the early1970s. Harvest was substantially reduced by restricting mainstem commercial fisheries and sport harvest in the mid-1970s. The calculated downward trend in abundance for the upper Columbia River stocks would be higher if the early redd counts had been revised to reflect the potential ‘transfer’ from harvest to escapement for the early years in the series.

In the 1960s and 1970s, spawning escapement estimates were relatively high with substantial year-to-year variability. Escapements declined in the early 1980s, then peaked at relatively high levels in the mid 1980s. Returns declined sharply in the late 1980s and early 1990s. Returns in 1990-94 were at the lowest levels observed in the 40-plus years of the data sets. The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for the populations returning to the Wenatchee, Entiat, and Methow drainages, respectively. The most recent 5-year geometric mean spawning escapements (1997-2001) were at 8%-15% of these levels. Target levels have not been exceeded since 1985 for the Methow run and the early 1970s for the Wenatchee and Entiat populations.

Short-term trends for the aggregate population areas reported in the 1998 Status Review (Myers et al. 1998) ranged from -15.3% (Methow R.) to a -37.4% (Wenatchee R.). The Escapements from 1996-1999 reflected that downward trend. Escapements increased substantially in 2000 and 2001 in all three systems. Returns to the Methow River and the Wenatchee River reflected the higher return rate on natural production as well as a large increase in contributions from supplementation programs. Short-term trends (1990-2001) in natural returns remain negative for all three upper Columbia River spring-run chinook salmon populations. Natural returns to the spawning grounds for the Entiat, Methow, and Wenatchee River populations continued downward at average rates of 3%, 10%, and 16% respectively.

Short- and long-term trends in returns to the individual subpopulations within the Wenatchee and Methow systems were consistent with the aggregate population level trends. Long-term and short-term trends for Upper Columbia River spring-run chinook salmon populations are shown in Figures A.2.3.7-A.2.3.8.

McClure et al. (in press) reported standardized quantitative risk assessment results for 152 listed salmon stocks in the Columbia River basin, including representative data sets (1980-2000 return years) for upper Columbia River spring-run chinook salmon. Average annual growth rate

---

[4]Prior to 1987, annual redd counts were obtained from single surveys and reported as peak counts. From 1987 on, redd counts were derived from multiple surveys and are reported as annual total counts. An adjustment factor of 1.7 was used to expand the pre-1987 redd counts for comparison with the more recent total counts. (Beamesderfer et al. 1997).

(λ) for the upper spring-run chinook salmon population was estimated as 0.85, the lowest average reported for any of the Columbia River ESUs analyzed in the study. Assuming that population growth rates were to continue at the 1980-2000 levels, upper Columbia River spring-run chinook salmon populations are projected to have a very high probability of a 90% decline within 50 years (0.87 for the Methow River population, 1.0 for the Wenatchee and Entiat runs).

The major harvest impacts on upper Columbia River spring-run chinook salmon have been in mainstem fisheries below McNary Dam and in sport fisheries in each tributary. There are no specific estimates of historical harvest impacts on upper Columbia River spring-run chinook salmon runs. Assuming that upper Columbia River spring-run chinook salmon runs were equally available to mainstem commercial fisheries as were the runs to other areas of the Snake and Columbia rivers, harvest rates in the lower river commercial fisheries were likely on the order of 20%-40% of the in-river run. Lower river harvest rates on up-river spring-run chinook salmon stocks were sharply curtailed beginning in 1980 and were again reduced after the listing of Snake River spring/summer-run chinook salmon in the early 1990s. Sport fishery impacts were also curtailed. Harvest impacts are currently being managed under a harvest management schedule—harvest rates are curtailed even further if the average return drops below a predefined level, increases area allowed at high run sizes.

Mainstem hydropower impacts

Upper Columbia spring chinook runs are subject to passage mortalities associated with mainstem hydroelectric projects. Production from all of these drainages passes through the four lower river federal projects and a varying number of Mid-Columbia River Public Utility District projects. The Wenatchee River enters the Columbia River above seven mainstem dams, the Entiat above eight dams; the Methow River and Okanogan Rivers above nine dams. The draft Mid-Columbia Habitat Conservation Plan establishes salmonid survival objectives for Wells, Rocky Reach, and Rock Island dams. After 1998, Douglas PUD began operating Wells Dam in accordance with the draft HCP. Although some operational improvements were implemented throughout the 1990's, measures to fully implement the provisions of the draft HCP were not in place at all three projects until 2003. Interim operating guidelines designed to improve survival have been applied at Wanapum and Priest Rapids Dams. Operational improvements have been made to increase outmigrant survival through the lower Columbia mainstem hydroelectric dams (FCRPS Biological Opinion 2000).

Each of the upper Columbia River spring-run chinook salmon areas has a particular set of habitat problems. In general, tributary habitat problems affecting this ESU include the effects of increasing urbanization on the lower reaches, irrigation/flow diversions in up-river sections of the major drainage, and the impacts of grazing on middle reaches.

Previous assessments of stocks within this ESU have identified several as being at risk or of concern. WDF et al. (1993) considered nine stocks within this ESU, of which eight were considered to be of native origin and predominately natural production. The status of all nine stocks was considered as depressed.

Nehlsen et al. (1991) listed six additional stocks from the upper Columbia River as extinct. All of those stocks were associated with drainages entering the Columbia River main stem above Chief Joseph and Grand Coulee Dams. Those projects blocked off access by adult anadromous fish to the upper basin.

Table A.2.3.1. Summary of abundance and trend information for Upper Columbia River spring-run chinook salmon relative to previous BRT status review. Five-year geometric means calculated using years 1997 to 2001 unless otherwise noted. Interim targets from Ford et al. (2001). Previous years 1987-1996.

Population(s)	Recent 5-year geometric mean				Short-Term Trend (%/yr)		Interim Target	Current vs. Interim Target
	% Natural Origin (prev.)	Total	Natural					
		Mean (Range)	Current	Previous	Current	Previous		
Methow Total *	41	680 (79 – 9,904)	282	144	+2.0	-15.3	2,000	34%
Methow R. Main stem *	41	161 Redds (17 –2,864)			+6.5			
Twisp R. *	46	58 Redds (10 – 369)		87	-9.8	-27.4		
Chewuch R. *	59	58 Redds (6 – 1105)		62	-2.9	-28.1		
Lost/Early Winters Cr. *	46	12 (3 – 164)	6	62**	-14.1	-23.2**		
Entiat R.	58	111 (53 – 444)	65	89	-1.2	-19.4	500	22%
Wenatchee Total	58	470 (119 – 4,446)	274	27	-1.5	-37.4	3,750	13%
Chiwawa R.	53	109 Redds (34 – 1,046)		134	-0.7	-29.3		
Nason Cr.	61	54 Redds (8 – 374)		85	-1.5	-26.0		
Upper Wenatchee	34	8 Redds (0 – 215)			-8.9			
White R.	92	9 Redds (1 – 104)		25	-6.6	-35.9		
Little Wenatchee	79	11 Redds (3 – 74)		57	-25.8	-25.8		

* 5 year geometric mean calculated without year 1998; no data available
** Lost River Only

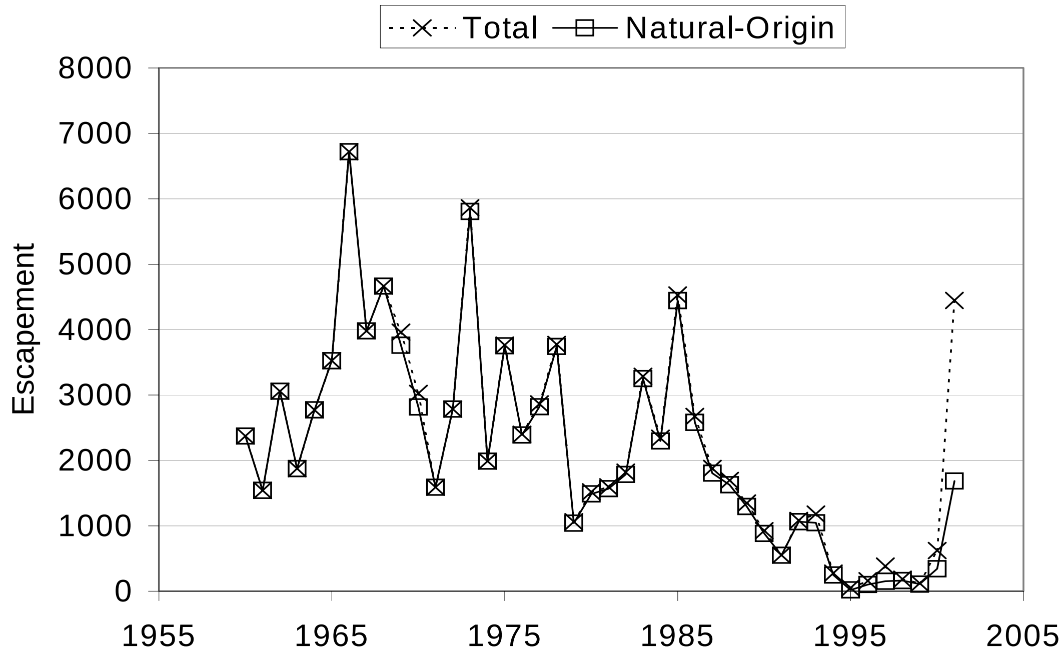

Figure A.2.3.1. Wenatchee spring-run chinook salmon spawning escapement; estimates expanded from redd counts (Beamesderfer et al. 1997, Cooney 2001). Recent year data from Mosey & Murphy (2002).

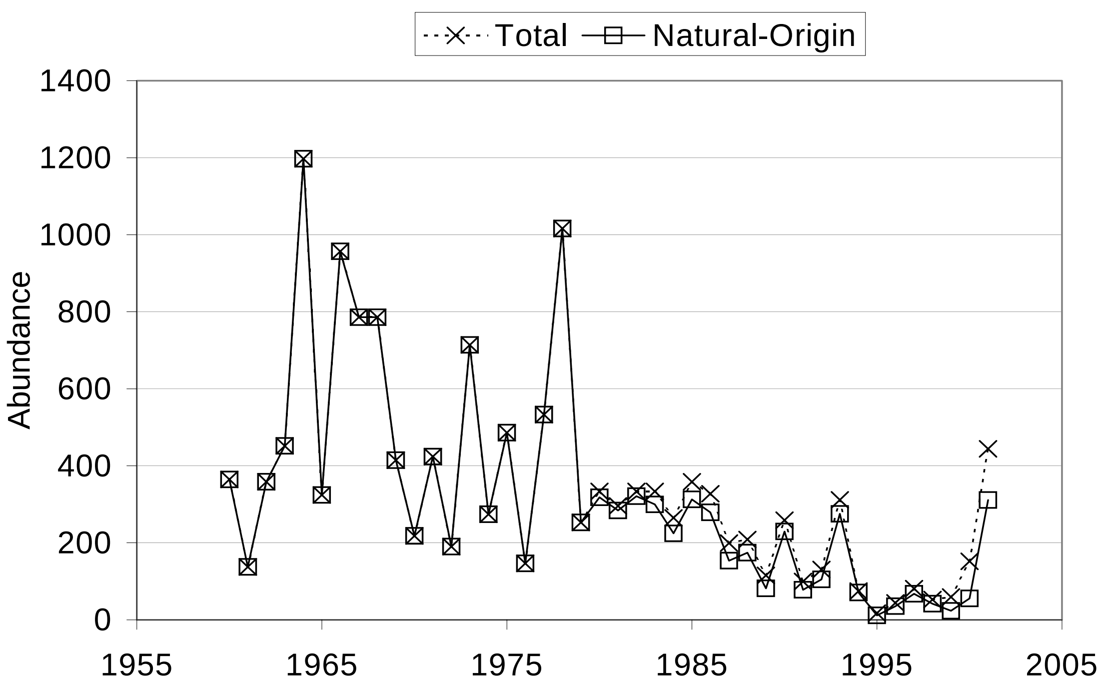

Figure A.2.3.2. Entiat spring-run chinook salmon spawning escapement; estimates from expanded redd counts (Beamesderfer et al. 1997, Cooney 2001). Recent-year data from Carie (2002).

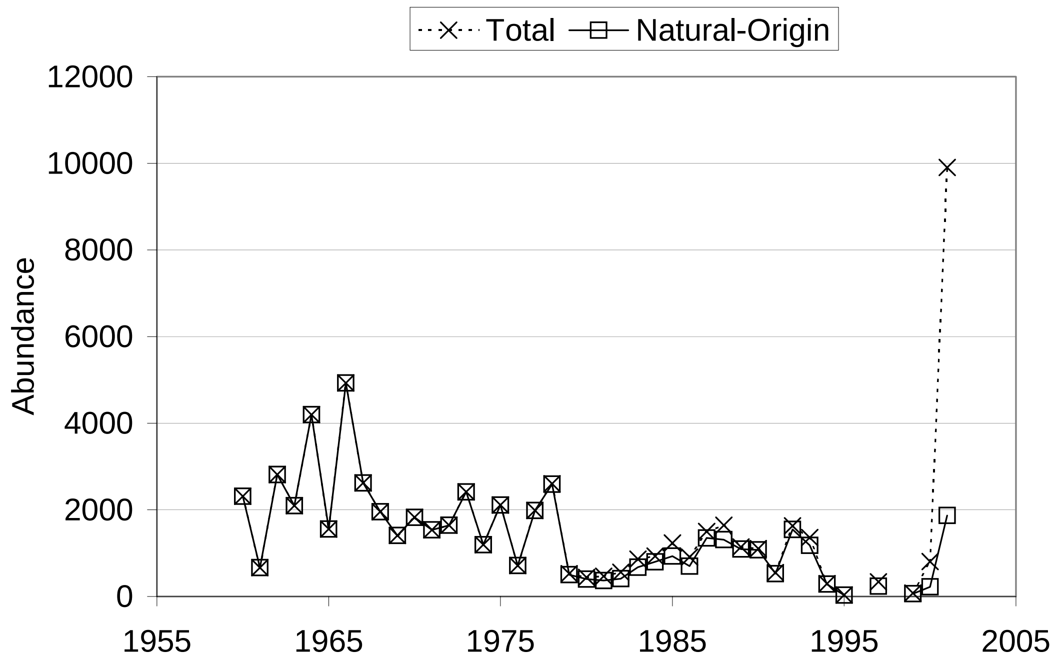

Figure A.2.3.3. Methow spring-run chinook salmon spawning escapement; estimates expanded from redd counts (Beamesderfer et al. 1997, Cooney 2001). Recent year data from Yakima Indian Nation Fisheries (J. Hubbell, pers. comm.).

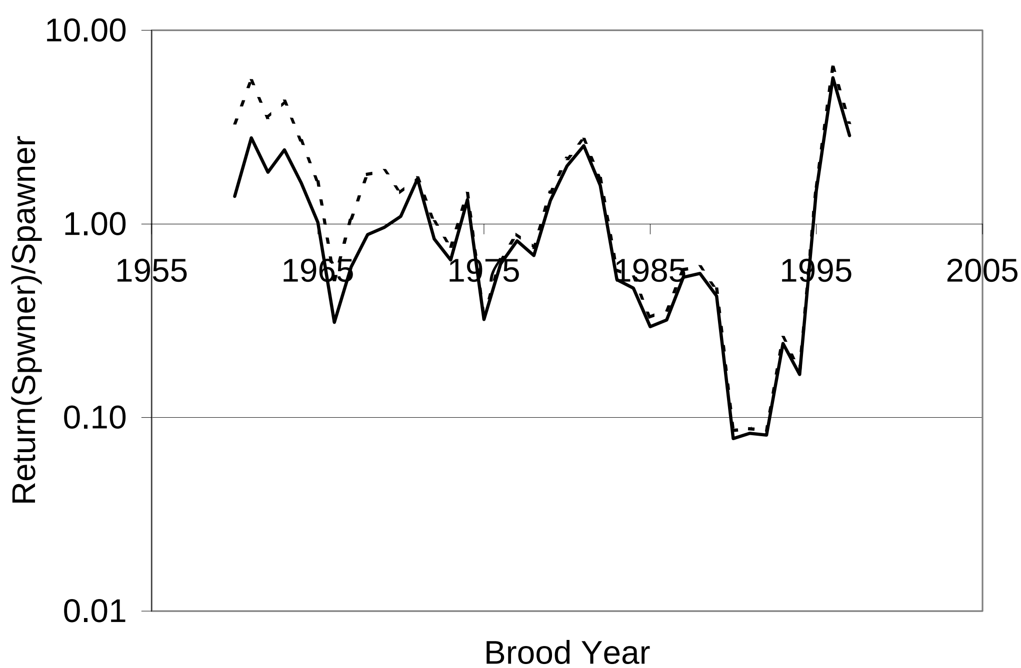

Figure A.2.3.4. Wenatchee spring-run chinook salmon returns/spawner by broodyear (returns to spawning grounds), calculated as estimated natural returns to the spawning grounds divided by brood year total spawners (solid line) and returns adjusted to recent average harvest rate (1985-2001; dashed line).

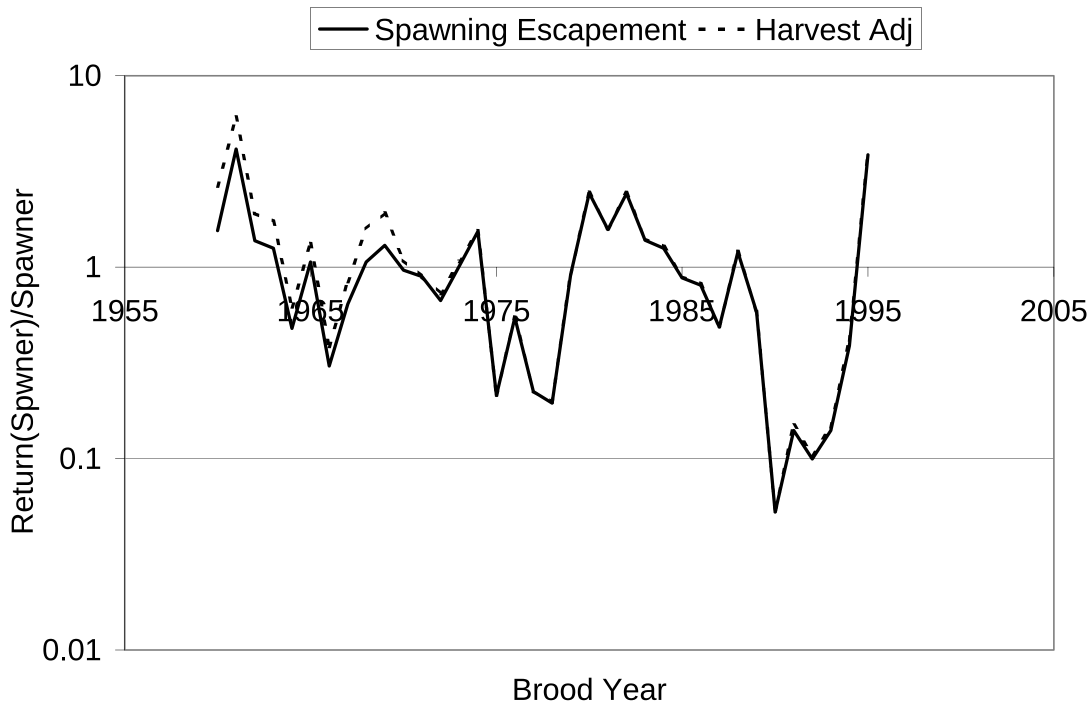

Figure A.2.3.5. Methow spring-run chinook salmon returns/spawner by brood year (returns to spawning grounds).

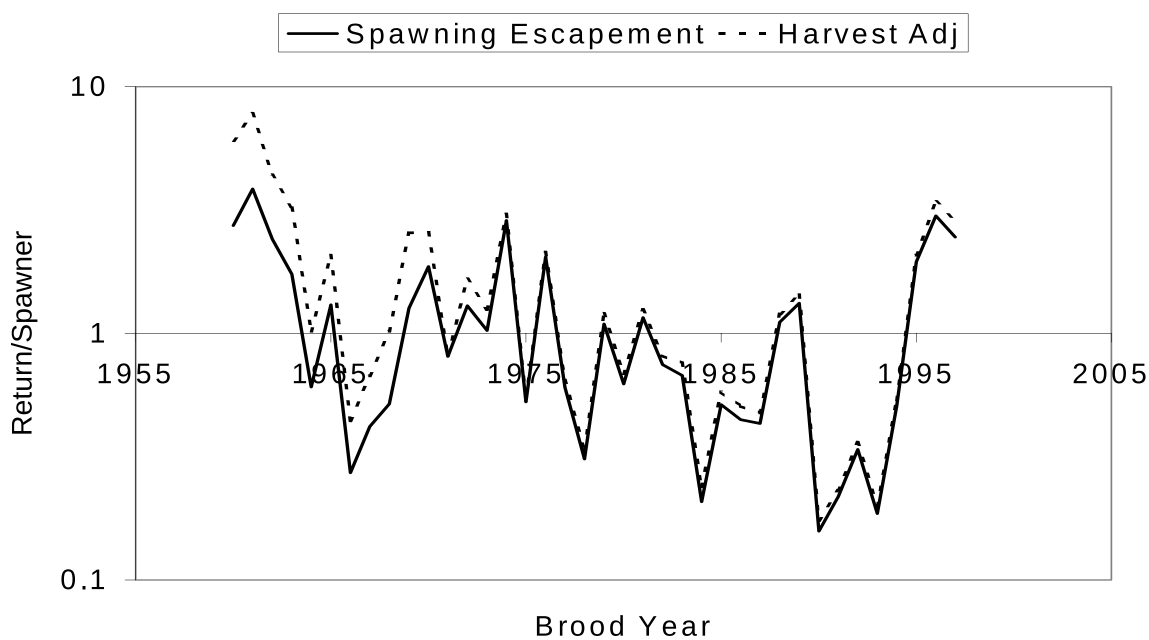

Figure A.2.3.6. Entiat spring-run chinook salmon returns/spawner by brood year (returns to spawning grounds).

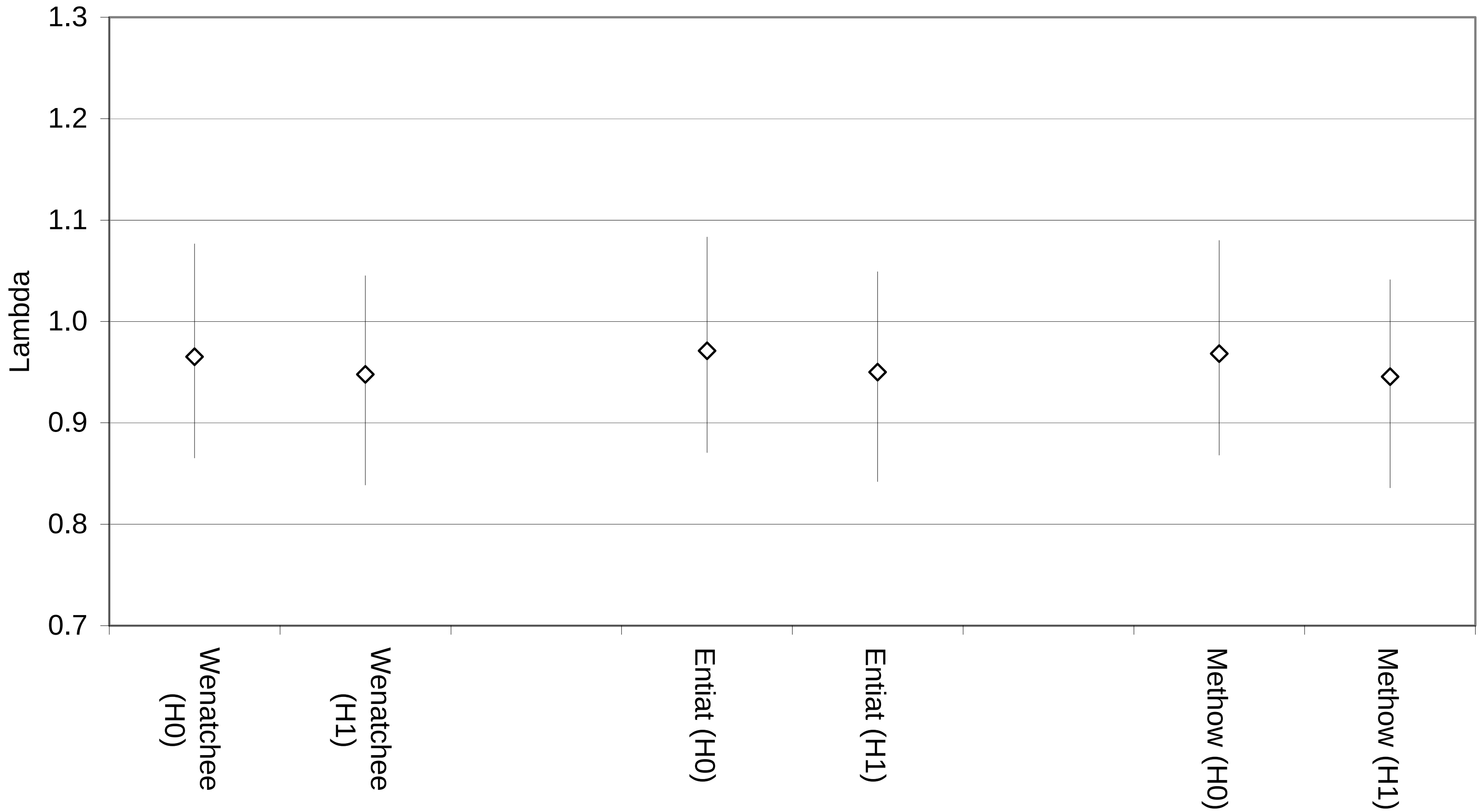

Figure A.2.3.7. Long-term annual growth rates (λ) for upper Columbia River spring chinook salmon populations. Error bars represent 95% confidence limits (H0 - hatchery fish are assumed to have zero reproductive success; H1 - hatchery –origin spawners are assumed to have the same reproductive success as natural-origin fish.).

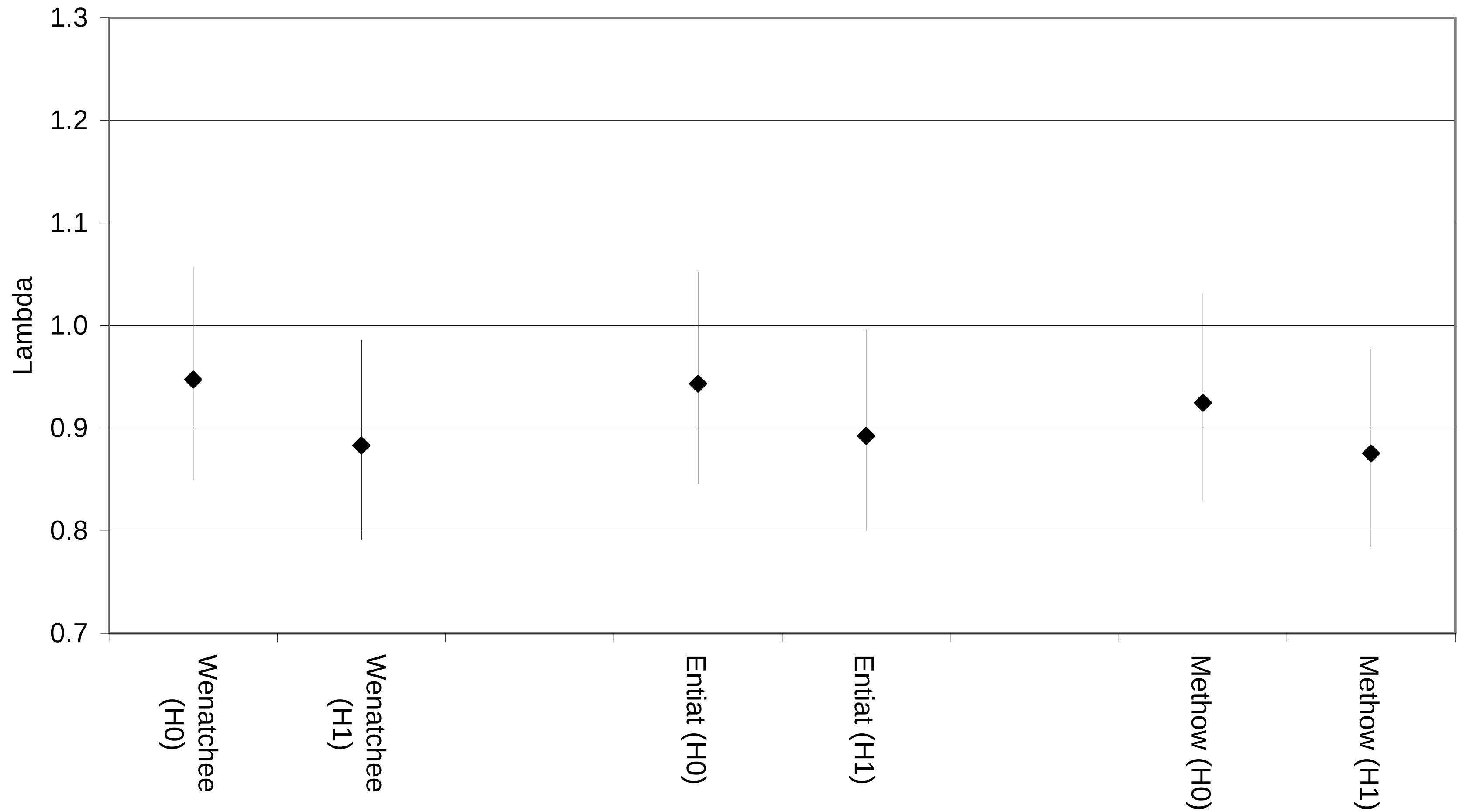

Figure A.2.3.8. Short-term (1990-2001) annual growth rates (λ) for upper Columbia River spring chinook salmon populations. Error bars represent 95% confidence limits of the trend (H0 - hatchery fish are assumed to have zero reproductive success; H1 – hatchery-origin spawners are assumed to have the same reproductive success as natural-origin fish).